RESEARCH ARTICLE

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Phytoremediation of Heavy Metals (Pb, Cd) by Tamarix along the Temby (karon) River, Iran

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Background & Aims of the Study: Heavy metals contaminate drinking water, air and soils. It is very harmful for humans and other live organisms. Phytoremediation is one of the direct bio-remediation methods for heavy metal removal from polluted water and soils. This method is accepted environmentally, economically and aesthetically. The purpose of this study was to assess Tamarix hispida capacity for heavy metals (lead and Cadmium) removal from Temby (Karon) river of Ahvaz, Iran.

Materials and Methods: This study was performed in summer season. Water samples took from upstream (before municipal wastewater discharge point) and downstream (after municipal wastewater discharge point). Samples of Tamarix hispida tree leaf took from those grown in downstream (after municipal sewage discharge place). In this study, inductively coupled plasma mass spectrometry (ICPMS) was used for analysis.

Results: Results of this study showed that lead and cadmium mean in summer were 0.5 and 0.077 mg/l in upstream; and they were 0.66 and 0.12 in downstream, respectively. According to the result, absorption rate of lead and cadmium by Tamarix hispida was 0.03 and 0.013 mg/l, respectively.

Conclusion: Results showed that Temby river water was polluted with Lead and Cadmium. Also,Tamarix hispida tree was effective for lead and cadmium removal. Lead was more uptake than Cadmium.

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Background

Wastewater collected from rural and urban communities which must eventually be returned to the water or soil (1-4). It is well recognized that human activity leads to the accumulation of large amounts of heavy metals in the soil which has been on a global scale (5-8). Numerous chemicals compounds, heavy metals and other industrial wastes in the coastal regions are as the result of discharge of industrial effluents into water in coastal areas. The toxic substances released into the environment and the food chain in different toxic consequences on living organisms (9-11). Cadmium is one of the most dangerous contaminants from soil, which has adverse effects, including preventing the growth of plant roots and shoots, sharp decline in products performance, the impact on nutrient uptake and biological balance. In addition, the

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metal accumulation in important crops and subsequently enter the food chain, a very serious problem for human health and the animals. Lead is another heavy metal that has unknown biological function and potential toxicity for plants and other living things. Many concerns have been originated for the metal, due to its wide distribution in urban and industrial societies and the potential risk to the environment, human and animal health (12-15). Temby river is one of the rivers in the city of MasjedSoleiman in Khuzestan province's eastern seaboard, Iran. The river crossed the border in the south western city of MasjedSoleyman, receiving municipal sewage and wastewater traditional slaughter of animals in the city and surrounding villages that are discharged into the river without treatment. The river from the edge of the city and the area known as Temby the public promenade and even local public swimming passes. However, due to the salinity of the river water used for drinking, but not due to join the Karon river in the northern city of Shushtar and the impact on the river's water quality is important at the regional level (16,17). Since, there areTamarix shrubs and salty deserts, this plant is often in waterways and rivers, saline and alkaline dry areas grow. The leaves are small and scale-like needles. Using phytoremediation to clean up a solution and inexpensive method directly (no intermediary) - earthy aqueous solutions of heavy metals. Plants with structure and adjustment mechanisms of pollutants to accumulate in high concentrations of pollutants in Rhizosphere are resistance (18). Technical methods of phytoremediation can be used for decontamination of soil, water and air contaminated with low levels of heavy metals and organic materials which were used (19). Manousaki et al (2009) surveyed Tamarix Smyrnensis Bunge for metal bearing properties and the ability to lead and cadmium accumulation. In other words, they used it in order to assess its effectiveness as a cleaning tool for the application of phytoremediation. In that study, they were performed two hydroponic experiments with different concentrations of lead and cadmium. Based on the result, the increased amount of salt in the branches can be increases the concentration of metal (20). Also, Manousaki in another study surveyed Tamarix Smyrnensis Bunge, the Mediterranean region has been widely extended to the accumulation of lead and cadmium heavy metals were examined (21). According to the result of this study, in the plant aerial and roots parts had large quantities of lead and cadmium (21). Rezaei Kahkha and colleagues (2013) studied the absorbtion ability of iron, lead and nickel heavy metals by leaf powder of Tamarix tree. Factors such as pH, contact time and initial concentration of dissolved metal solution with plants were optimized. The results of this study showed that the highest absorption rate at 24 hours and pH=4, as well as the initial concentration of 200 ppm is achieved. Some tests showed the plant uptake by the plant's potential to treatment of heavy metals from 58% for nickel and 65% for iron. Review of the plant's ability to absorb shows that the conventional absorbents such as activated carbon plant in comparison with the power of absorption is good (22). Now, increasing the concentration of heavy metals by microorganisms of the soil is not one of the main challenges in the field of environment. The different effects of these metals are cytotoxic, carcinogenic and mutagenic which are serious risks to human health and other living creatures.

Aims of the study:

The purpose of this study was the evaluation of lead and cadmium heavy metals removal by Tamarix tree in Karon river.

Materials & Methods

Methods

Tamarix shrubs and river water samples from Temby were tested after a preliminary review of the three stations in the study area for the

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existence of lead and cadmium heavy metals in river. Tamarix shrubs were able to absorb them. Water samples acidified by nitric acid to pH=2 and in combination with other samples were transported to the laboratory. Two liters of water samples put on the stove at a temperature of 80°C until its volume was 50 ml, then, the prepared samples for assessment of heavy metals were measured by ICPMS (23).
Plant samples were first washed with distilled water, then, in order to drying them, they were placed in petri dishes in the autoclave for 48 hours at 105°C (23). After drying, samples were crushed. Then, 2 gr of sample weighed on scales. For digestion of samples, they poured into plastic containers on the water bath (internal temperature 100°C). First, 5 ml of feloridric acid was added to plant samples. Then, 10 ml of nitric acid and 5 ml of hydrochloric acid were added again (20,23). After the completion of digestion, samples were smooth and by 4% nitric acid were reduced to 20 ml. In order to measuring the digested samples, Inductively Coupled Plasma spectrometry was used and poured into a sealed polyethylene container (24).

Statistical Analysis

The coded data were entered in SPSS version 16. Data analysis was performed, using descriptive statistics (frequency, mean and standard deviation for each variable).

Results

The results of the experiments showed that the maximum concentration of lead and cadmium before entering sewage were 0.6 and 0.09 ppm during July (Table 1). The amount of lead and cadmium in leaves of Tamarix and river water of Temby listed in table 1.

Table 1) The concentration of lead and cadmium in the water before entering wastewater (ppm)

Months	Lead	Cadmium
July	0.6	0.09
August	0.5	0.08
September	0.4	0.06
Average	0.5	0.077

Experiments which were conducted in the downstream of Temby resulted in the record of highest concentration of 0.8 ppm for lead in July and the lowest concentration of 0.11 ppm for cadmium in September (Table 2).

Table 2) The concentration of lead and cadmium in the water after entering wastewater (ppm)

Months	Lead	Cadmium
July	0.8	0.12
August	0.67	0.13
September	0.5	0.11
Average	0.66	0.12

The results of the digestion and determination of the concentration of leaf samples showed, in the downstream river after the sewage, there were the greatest attraction for lead and cadmium in September 0.065 and 0.1 mg/gr, respectively (Table 3).

Table 3) Studied concentration in leaves of Tamarix in downstream after entering wastewater (mg/ gr)

Months	Lead	Cadmium
July	0.04	0.05
August	0.05	0.05
September	0.065	0.1
Average	0.015	0.0065

The following graphs has shown the leaves of Tamarix concentration in the water upstream, downstream and their accumulation.
Figure 1 showed the concentration of lead in different months. Also, based on figure 1, the level of fallen in the water was slightly increased in leaves of Tamarix.
The concentration of cadmium in the water during different months showed in figure 2. An overall level of cadmium in leaves of Tamarix had reduction and slightly increased. Student`s

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t-Test between the amount of heavy metals in the water of upstream and downstream concentration difference and between the concentration of heavy metals in water and the accumulation in the leaves and stems Tamarix showed significant differences.

Compare the average level of heavy metals in Temby with standard value of heavy metals in drinking water and the water which were used for agriculture and aquatic showed that the average concentrations which were obtained for lead and cadmium within the limits were illegal for drinking water, agriculture and aquatic life (Table 4).

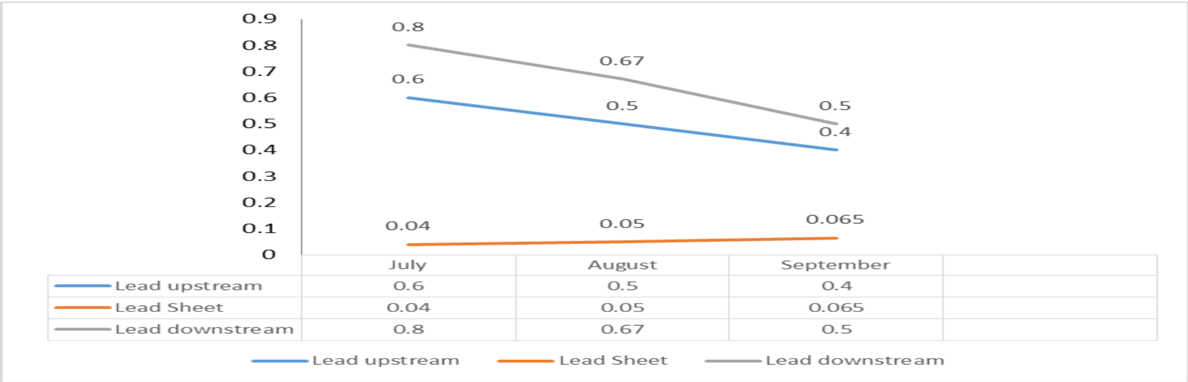

Figure 1) Lead concentrations in river water Temby and Tamarix tree leaves

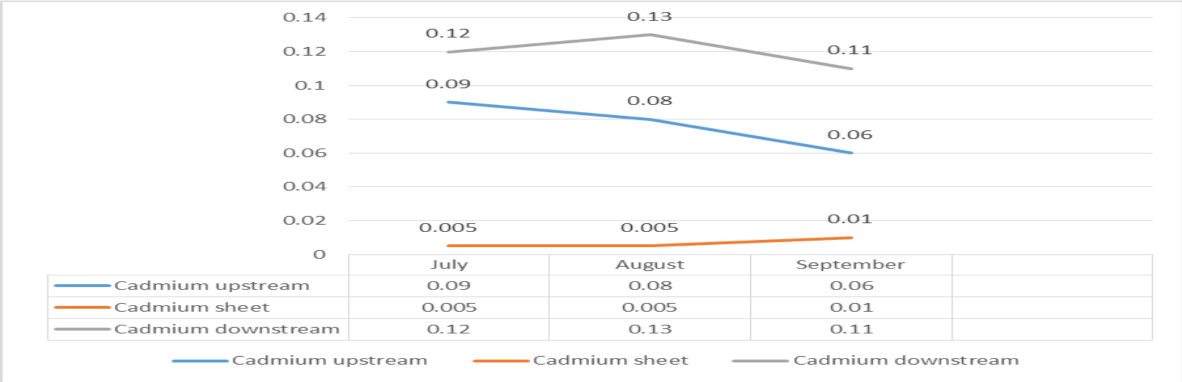

Figure 2) Cadmium concentrations in river water Temby and Tamarix tree leaves

Table 4) Comparison between the average concentrations obtained in the water upstream and downstream with national standards (ppm)

Heavy metal		Average	Standard for drinking water	Standard for water in agriculture	Water standard for aquatic life
Cd	Upstream	0.077	0.005	0.005	0.005
	Downstream	0.12			
Pb	Upstream	0.5	0.001	0	0.005
	Downstream	0.66			

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Discussion

According to the results, Temby river, in terms of standards of heavy metal pollution, is not suitable for drinking and marine life. According to the Student`s t-Test between the mean level of heavy metals in water of upstream and downstream, a significant difference (for lead p=0.033 and cadmium p=0.022) has been appeared. This showed the effect of slaughter house wastewater, hospitals, factories gas and sewage into the river that leads to high levels of lead and cadmium in the river. The results of the analysis of water samples of Temby upstream (before entering sewage) and downstream (after entering sewage) and leaf samples showed that the amount of heavy metals in downstream water was higher than the average of their concentration in upstream. The reson of this can be the result of the impact of wastewater flow.

According to the Student`s t-Test mean result, there is a difference between the concentrations of heavy metals in drinking water, the accumulation in leaves and stems; Tamarix reflects the ability of the tree to absorb heavy metals.

It should be noted that there are similar other plants such as needle-shaped leaves, sediment and aquatic organisms which will be effective in removing heavy metals from water.

Hosein zadeh et al in 2010 surveyed the lead absorption by plants, sunflower, mustard Hindi, tobacco, vote and their Aspynaj paid and the results showed that sunflower plant had the highest capacity to absorb lead. According to the result, the soil-plant because of having fiber deeper root can enhance apable of absorbing lead inroot level.

Since, the plant with the plant's Tamarix have the same performance and they are be able to absorb more lead than cadmium, it is similar in the way of the removal of lead by the plant Rhizofiltration mechanism (Phytofiltration) (12,25). In 2009, a study was done in order to estimate the effect of the treatment of lead and cadmium Phytoextraction by Tamarix smyrnensis Bunge in three different concentrations of salt by Manousaki and colleagues. The results stated that the concentration of lead and cadmium in shoot were higher and at the same time increasing the salt concentration increased uptake by plant and salinity and metal accumulation in shoots was also increased. Due to the fact that the Tamarix plant has the ability to grow in places with high salinity, it can be deduced that the mechanism of absorption of lead and cadmium which was absorbed by plants manning existing in the presence of salt in plant structures, Phytoextraction method is followed (20).

The study of Manousaki and colleagues in the year 2005 obtained the highest amount of lead and cadmium which was uptake by plants Tamarix smyrnensis. In this study, the most widely and the lowest concentration of pollutants in the soil were examined to estimate the maximum absorption of lead and cadmium which were added. They reported that the maximum amount of absorbance of lead and cadmium were in plant roots. Another important factor in plant grows and ability to excrete excess were soil types (21).

In the year 2013, Rezaei Kahkha and colleagues studied the ability to absorb iron, lead and nickel heavy metals by Tamarix leaves. The result was expressed that Tamarix plant compared to conventional absorbents such as activated carbon absorption is good. Also, this plant is similar to Tamarix hispida plant structurally and in other words, the plant's ability to absorb lead and cadmium is good (22).

Based on the overall results of this research, Temby river lead and cadmium heavy metals are present in this study and contaminants in the water can increase the level of these elements. According to the result of our study, discharged municipal, domestic and industrial wastewater into the river are the most agents which

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increase the concentration of heavy metals espicially lead and cadmium in this aqueous.

Conclusion

The test results were expressed as Tamarix shrubs due to resistance to salinity and salt crystals. Based on the result of this study, the most important factors of Rhizofiltration (Phytofiltration) and Phytoextraction mechanisms are salt crystals, surfaces of leaves and the ability of roots in removal of lead and cadmium. Also, it can be said that Tamarix plant hispida as one of the effective natural methods of removing heavy metals such as metals investigated in this study (lead and cadmium). It should be noted that researches and studies in this field and study of the different aspects of these plants for phytoremediation are necessary.

Footnotes

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Conflict of Interest:

The authors declared no conflict of interest.

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