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ORIGINAL ARTICLE

Phytoremediation Power of Heavy Metals by Tree Species in Urban Green Spaces

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ABSTRACT
Pollution of heavy metals due to stability in the environment has great importance and phytoremediation is introduced as one of the cheapest, cleanest and most practical methods for it. This study was carried out to determine phytoremediation power of Robinia psedoacacia, Pinus nigra, Cupressus sempervirense var. arizonica for cadmium (Cd) and lead (Pb) absorption. Sampling from leaves and bark of mentioned trees were done in completely randomized design with five replications. It was conducted in control (Mirdamad Park of Tabriz) and polluted (Sufian) regions. After extraction, Cd and Pb of samples were measured by atomic absorption spectrometry. The results revealed that Robinia psedoacacia absorbed most Cd and Pb, and was ranked in the first statically class. Therefore, it is recommended as absorbent of heavy metals and sowing in urban green spaces of contaminated regions to reduce pollutant levels and purify atmosphere.
Keywords: *phytoremediation, heavy metals, cadmium, lead, urban green spaces, atomic absorption spectrophotometer*

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INTRODUCTION

Population growth and industrialization of societies have some consequences such as air and soil pollution. Heavy metals (even in low concentrations) due to inseparability and physiological effects on living organisms are one of ecosystem disrupting factors [1], which is still in need of an effective and affordable technological solution [2]. Law amounts of heavy metals as micronutrients are essential for plants growth. Whereas, large amounts may cause disturbance in their metabolism and stop in growth [3]. Heavy metals do not degrade in the environment and their discharging is so vital. Moreover, high costs of many physical and chemical methods lead to efforts for achieving cheaper methods like biological resources (green plants), which has been named phytoremediation [4]. This is a promising approach for remediation heavy metals from polluted environment [2, 5]. In addition, it has five various technologies that each of them has special mechanism for pollution refinement. Many hyperaccumulater plants have been identified up to now that have innate capacity for metal absorption at levels 100 times more than others [6]. It is notable that most of these plants belong to the food and rangelands plants. Therefore, heavy metals may enter the food chain and threaten human health. In other word, ornamental plants and green spaces are suitable options for solving this problem [7].
According to the importance of phytoremediation by plants of green spaces, *Robinia psedoacacia*, *Pinus nigra*, *Cupressus sempervirense var. arizonica* were selected for evaluating their ability in cadmium (Cd) and lead (Pb) absorption, and cleaning urban spaces.

MATERIALS AND METHODS

Research areas are located in Mirdamad-Tabriz and Sufian cities, in East Azarbaijan Province, NW Iran (Fig. 1). The province has a surface area of 45490.88 km^2 with cold and mountainous climate with 250-300 mm precipitation. By visiting the Department of Environment and Parks of the Province, Mirdamad Park of Tabriz and Sufian were identified and recommended as control and contaminated areas, respectively. The species of planted trees in green spaces of the regions were identified and three species (*Robinia psedoacacia*, *Pinus nigra* and *Cupressus sempervirense var. arizonica*) which were common between two regions were selected for the study. Leaves and bark samples of mentioned trees were prepared so that they were selected from E and NE part of trees (direction of the prevailing wind of studied regions) and transferred to the laboratory of Islamic Azad University of Shabesrtar, Iran. The test samples were washed with distilled water and oven-dried at 75°C for 48h. Dried samples were powdered with electric mills, and 10g of each sample with 50 ml nitric acid was poured into the flask and placed in laboratory temperature for 15 min. For better digestion, the flasks were transferred to heater with 95°C for 15 min, then moved under chamber of hood for vapor exit and cooling. Extracts were evaluated by Atomic Absorption Spectrophotometer (Varian Spectr AA 220) after passing through filter paper.

Obtained data were analyzed by SPSS (ver.22) software. Two-way analysis of variance and Duncan's multiple range tests were used for evaluating the significance of species and sampling places and mean comparison, respectively.

RESULTS AND DISCUSSION

Variance analysis indicated that the effect of regions and species were significant for all of evaluated traits. Whereas, interaction among them was only different for Pb accumulation in leaf and bark of the trees (Table 1).

Pb accumulation in leaf and bark of *Robinia psedoacacia* (*Rp*) was 15.86 and 8.18% higher than the other species, respectively. Moreover, this species showed the highest accumulation of Cd in leaf and bark. Although Pb and Cd accumulation in leaf and bark of *Pinus nigra* (*Pn*) was higher compared to *Cupressus sempervirense* (*Cs*), both of them were statistically located in same group (Table 2). Accumulation of Pb in *Rp* was increased from 0.211 to 0.233 mg/g. In addition, there was 21.95% increase in Cd accumulation (Table 3).

Interaction among studied variables revealed that *Rp* in Sufian had the most absorption of heavy metals and accumulated them in its leaves and bark. The lowest absorption of Cd belonged to leaf and bark of *Pn*, which was 67.74 and 70.68% less than *Rp* absorption, respectively. *Cs* had the lowest accumulation of Pb in bark (0.099 mg/g), which had no significant difference with *Rp* absorption (Table 4). The high level of Pb (0.347 mg/g) and Cd (0.060 mg/g) absorption was with *Rp* species in Sufian. Although the lowest level of Pb and Cd accumulation belonged to *Cs* in Tabriz, it was in same statistically class with *Pn* in Tabriz (Table 5).

Results of this study indicated that absorption of Pb and Cd in Sufian was significantly higher than Tabriz. Environmental factors, topography of the region and drying up of Urmia Lake in south of the province are some reasons which increase pollutant of heavy metals in the atmosphere of Sufian. Therefore, trees with more phytoremediation power absorb high levels of heavy metals [8]. Moreover, *Rp* due to globular crown, hairy leaves, high coefficient of leaf area and corky bough absorbed more Cd and Pb, and *Pn* and *Cs* were statistically placed in the second and third group, respectively. These results were matched with other researchers' findings about phytoremediation ability of *Rp*, *Cs* and *Pn* [1, 9, 10]. *Rp* is introduced as successful species in Pb and Cd absorption, pollutant reducing and air purification in contaminated urban spaces.

Table 1: Variance analysis of studied factors on accumulation of heavy metals.

Traits Effect	df	Mean squares			
		Pb of leaf	Pb of bark	Cd of leaf	Cd of bark
Region	1	0.344**	0.341**	0.008**	0.008**
Species	2	0.005**	0.001**	0.000**	0**
R × S	2	0.000**	0.001**	4.083ns	5.583ns
Error	24	1	1	1	1

ns, non significant; *, significant at P≤0.05; **, significant at P≤0.01.

Table 2: Effect of species on accumulation of heavy metals in leaf and bark.

Evaluated species	Pb of leaf (mg/g)	Pb of bark (mg/g)	Cd of leaf (mg/g)	Cd of bark (mg/g)
Pinus nigra	0.207b	0.216b	0.036b	0.034b
Cupressus sempervirense	0.207b	0.202c	0.033b	0.031b
Robinia psedoacacia	0.246a	0.220a	0.043a	0.040a

Means in a column followed by the same letter are not significantly different at P≤0.01.

Table 3: Effect of species on accumulation of heavy metals.

Evaluated species	Pb accumulation (mg/g)	Cd accumulation (mg/g)
Pinus nigra	0.211b	0.035b
Cupressus sempervirense	0.204c	0.032c
Robinia psedoacacia	0.233a	0.041a

Means in a column followed by the same letter are not significantly different at P≤0.01.

Table 4: Interaction among regions and species on accumulation of heavy metals in leaf and bark.

Regions	species	Pb of leaf (mg/g)	Pb of bark (mg/g)	Cd of leaf (mg/g)	Cd of bark (mg/g)
Tabriz	*Pinus nigra*	0.102d	0.118d	0.020d	0.017e
	Cupressus sempervirense	0.106d	0.099e	0.019d	0.018de
	Robinia psedoacacia	0.136c	0.102e	0.025c	0.022d
Sufian	*Pinus nigra*	0.312b	0.315b	0.052b	0.051b
	Cupressus sempervirense	0.308b	0.306c	0.048b	0.045c
	Robinia psedoacacia	0.357a	0.338a	0.062a	0.058a

Means in a column followed by the same letter are not significantly different at P≤0.01.

Table 5: Interaction among regions and species on accumulation of heavy metals.

Regions	species	Pb accumulation (mg/g)	Cd accumulation (mg/g)
Tabriz	*Pinus nigra*	0.110d	0.018e
	Cupressus sempervirense	0.102d	0.018e
	Robinia psedoacacia	0.119c	0.023d
Sufian	*Pinus nigra*	0.313b	0.051b
	Cupressus sempervirense	0.307b	0.046c
	Robinia psedoacacia	0.347a	0.060a

Means in a column followed by the same letter are not significantly different at P≤0.01.

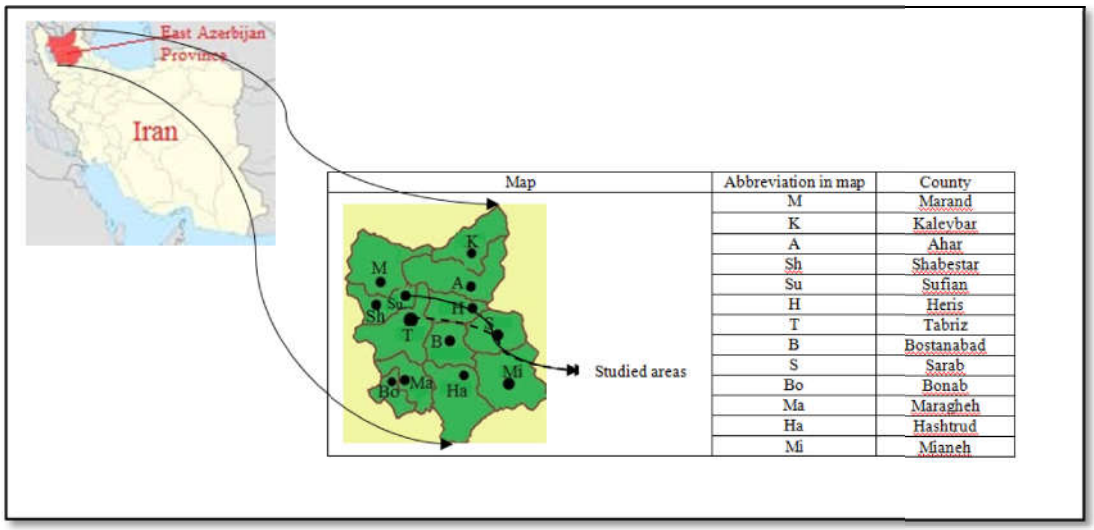

Figure 1: Studied areas

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