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Original Article

The concentration of some heavy metals in different parts of reed plant *Phragmites australis*, along the Al-Sabeel River, Iraq

Eman Abbas Jaber*, Dunia Bahel Gadaan Al-Ghanimy*

Department of Biology, College of Education, Al-Qadisiyah University, Al-Diwaniyah, Iraq.

Abstract: The present study was conducted to determine the concentrations of some heavy metals of lead, cadmium, and chromium in the roots and stems of *Phragmites australis* collected from the Al-Sabeel River in Iraq. Samples were collected at four selected sites in three provinces of Najaf, Diwaniyah, and Samawah over a distance of 114 km, from August 2022 to January 2023. The results reveal that the concentrations of Pb, Cd, and Cr in the roots and stems of the reeds as 134.28-91.21, 189.47-180, and 190.57-97.9 mg/kg dry weight, respectively. Cr was the most accumulated element in the stem, while Cd was the most accumulated in the roots. The results also showed that the stem accumulates heavy metals more than the roots, indicating the possibility of using the reed as an indicator of heavy metal pollution.

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Introduction

Pollution is one of the most serious nowadays concerns worldwide, as it poses a threat to human survival (Singh and Agrawal, 2010). It has significant economic, environmental, and social dimensions, especially after industrial and technological development causing deterioration of the natural ecosystem (Kamran et al., 2014). Water pollution with organic and inorganic materials results in rendering water quality unsuitable for human use (Eid et al., 2012). In this order, heavy metal pollution poses a serious threat to the aquatic environments.

Heavy metals have a density of more than 5 g/cm^3 (Environmental Protection Agency, 2003), and are found in all ecosystems (Adelekan and Abegunde, 2011; Ahmed et al., 2015). Urban and industrial development, metals processing, painting, electronics, and surface runoff play crucial roles in polluting water bodies with heavy metals (Islam et al., 2015; Gupta et al., 2012). The natural weathering of rocks in the Earth's crust is also a source of heavy metal pollution (Taiwo et al., 2014).

The risk of heavy metals to the aquatic environment arises from their non-biodegradability and their accumulation over time in the food chain, causing various damages to living organisms (Doke et al., 2012). There are several advanced techniques to reduce the negative impact of heavy metals, including natural biodegradable materials that are renewable, inexpensive, abundant, and have the ability to remove heavy metal ions (Sheba and Nandini, 2016). Phytoremediation is one of the methods in which types of plants are used to treat pollution of heavy metals because they can reduce, decompose, or remove pollutants using their parts such as leaves, roots, shoots, or cell walls (Sharma, 2015). Many plants can absorb pollutants from water, soil, and air and accumulate them in their tissues without causing harm to themselves, thus playing an important role in treating or reducing the environmental pollution in their presence (Ismail, 2012).

Aquatic plants are used as biological indicators for detecting the presence of heavy metals, in addition to their importance in preserving the nature of the exposed bed (Bonanno, 2013). This method depends on the type and concentration of the pollutants (Yasseen, 2014). Hence, it is important to determine the concentrations of some heavy metals in the roots

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E-mail: eman.alj444@gmail.com; dunia.gadaan@qu.edu.iq

and stems of the reed in the water bodies to understand the plant parts that are most capable of accumulating heavy metals. Therefore, this study aimed to determine the concentrations of some heavy metals of Cd, Cr, and Pb in the roots and stems of the common reed, *Phragmites australis* collected from the Al-Sabeel River in Iraq.

Materials and Methods

The samples of *P. australis* were manually collected over six months starting from August 2022 to January 2023 along the Al-Sabeel River at four sites: the first site was at the beginning of entering the Al-Sabeel River, Al-Qadisiyah district, Najaf Governorate. The second site was in Al-Gharb village, Al-Shanafiya district, Diwaniyah Governorate, the third site was in Al-Hilal sub-district, Al-Rumaythah district, Muthanna Governorate, and the fourth site was in Al-Majd sub-district, Al-Rumaythah district, Muthanna Governorate (Fig. 1).

The collected samples were placed in clean plastic bags after being washed with river water to remove impurities and debris. They were then transported to the laboratory and washed with tap water and distilled water, followed by a rinse with ion-free water. The roots and stems were separated and dried thoroughly, after which heavy metals were extracted from the plant according to the method described by Antonijevic and Maric (2008). A Flame Atomic Absorption Spectrophotometer was used to measure the heavy metal ion concentrations, after preparing standard solutions according to APHA (2003)

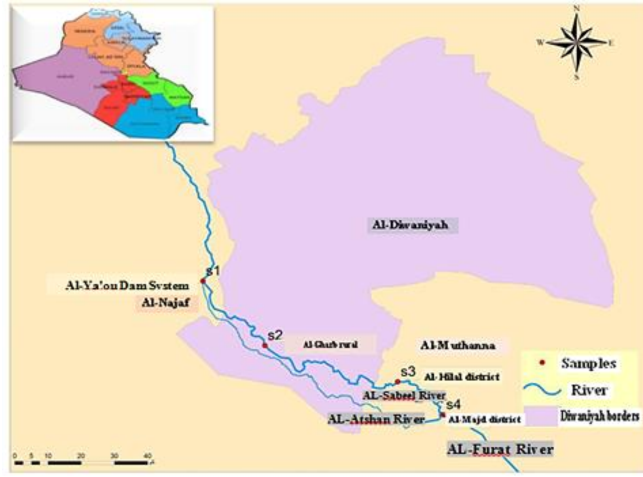

Figure 1. Map of the studied sites in AL-Sabeel River.

Results and Discussions

The results indicated that the order of heavy metals in the stem of the reed was as follows: Cr < Cd < Pb, with concentrations of 190.57, 189.47, and 134.28 mg/kg dry weight, respectively (Table 1). In the roots, the order of metals was as follows: Cd < Cr < Pb, with concentrations of 180, 97.9, and 91.21 mg/kg dry weight, respectively. The phytoremediation technique is used to absorb and reduce heavy metals from the environment by storing them in plant tissues (Lajayer et al., 2019). Aquatic plants can accumulate pollutants in their bodies at a higher level regardless of their concentrations in the environment (Zurayk et al., 2001). The ability of aquatic plants to accumulate heavy metals depends on several environmental factors, such as salinity, temperature, season, and pH, as well as the age and type of the plant (Bonnano and Giudice, 2010).

The results showed differences in the concentrations of heavy metals between the roots and stems of the reed plant across months and sites. The local variations may be attributed to the impact of household and agricultural waste that flows into the river (Torres et al., 2010). Additionally, variations in the genetic traits of the plant species and environmental conditions contribute to the differences in the plant's ability to accumulate heavy metals (Kabata-Pendias and Pendias, 1984).

Regarding the differences in heavy metals concentrations during the present study months, the highest values for heavy element concentrations in the reed stems were recorded in November, which may be attributed to the high rainfall and water flow causing the leaching of many dissolved salts (Netshiongolwe et al., 2020), or the use of fertilizers and pesticides containing these metals, leading to an increase in heavy element concentrations in plants (Mahmoud et al., 2018).

This study showed that the stem of the reed has more accumulator of heavy metals than the roots. This is because reed is known for its ability to accumulate

Table 1. Different concentrations of heavy metals in the roots and stem of the reed plant.

Metal	Site	August		September		October		November		December		January	
		Stem	Root	Stem	Root	Stem	Root	Stem	Root	Stem	Root	Stem	Root
Pb	S1	83.63	81.13	82.02	77.0	62.18	23.51	53.27	57.2	52.13	58.76	37.43	43.15
	S2	51.1	91.21	79.2	67.2	23.49	23.14	75.36	25.53	65.39	32.02	48.85	54.60
	S3	29.22	18.268	74.4	21.40	78.52	64.26	76.41	87.54	58.65	55.28	60.33	67.05
	S4	69.4	68.08	65.1	48.9	57.32	53.26	134.28	85.63	48.52	72.71	71.75	77.50
Cd	S1	54.1	26.0	37	24.0	87.75	79.08	166.54	133.67	105.62	98.47	86.72	17.63
	S2	78	22.1	93.2	82	122.14	56.92	189.47	180	87.39	73.94	58.73	115.63
	S3	93	58	33.0	70.1	96.82	33.24	92.62	45.11	89.03	68.52	106.74	99.53
	S4	97.3	74.7	42.5	27.30	54.98	79.12	97.37	26.61	79.83	57.83	97.62	98.42
Cr	S1	90.54	82.01	64.7	65.17	24.61	67.51	175.86	83.42	19.13	21.97	12.47	10.64
	S2	20.5	90.3	47.01	46.5	45.82	76.59	156.62	96.75	24.81	27.65	88.12	69.84
	S3	72.14	39.7	69.8	97.80	45.36	89.43	142.13	70.43	30.49	25.71	51.55	33.28
	S4	82.1	97.9	81.40	94.01	87.60	94.30	190.57	33.43	29.61	33.51	56.62	96.75

(Table 1). The reed stem possesses a structure filled with air spaces (Kattel et al., 2020). Moreover, as an emergent aquatic plant, the reed has parts of its body in water and other parts in the air, giving the stem a greater chance to absorb heavy metals through atmospheric deposits containing pollutants (Daylam-Jafarabad et al., 2013). Additionally, the stem has high biomass (Brezinova and Vymazal, 2015), and our results are in agreement with the findings of Chandra et al. (2018).

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