PHYTOREMEDIATION POTENTIAL OF MAJOR AQUATIC PLANTS COLLECTED FROM DIFFERENT AQUA-CONTAMINATED SITES OF DISTRICT SARGODHA

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Abstract- The present study was conducted to find out the phytoremediation potential of major aquatic plants collected from different aqua-contaminated sites of district Sargodha i.e., S1(Bhalwaal, Bhehra), S2(Sargodha city, Shahpur), S3(Silanwali, Sahiwaal). Plants include *Carex haydenii* (P1), *Typha angustifolia* (P2), *Lemna gibba* (P3), *Lemna minor* (P4) and *Phragmites communis* (P5). Results of the elemental analysis showed that the highest phytoremediation potential of Sn (87.86 mg/Kg) and Ag (0.73 mg/Kg) was observed in P1 collected from S1 and S2 respectively while the highest phytoremediation potential for Sb (2.17 mg/Kg), Cu (5.84 mg/Kg), Mo (3.47 mg/Kg), Fe (226.75 mg/Kg), Zn (39.50 mg/Kg), and Co (3.50 mg/Kg), Mn (9.44 mg/Kg), Pb (3.26 mg/Kg) was observed in P2 collected from S1 and S3 respectively. Highest concentration of Hg (1.76 mg/Kg), As (0.79 mg/Kg) and Cr (1.90 mg/Kg), Ni (21.45 mg/Kg) was observed in P3 collected from S1 and S3 respectively. However, the maximum concentration of Cd (2.51 mg/Kg) was noted in P5 collected from S1. Variation in phytoremediation potential for metals was present in all plants, even in the same plants collected from different sites of district Sargodha which may attributed to source, type and quantity of contaminations present on aqua sites or may attributed to spatial variation which is present in all plant samples.

Index Terms- Phytoremediation potential, Aquatic Plants, District Sargodha.

I. INTRODUCTION

Heavy metal contamination is a global problem. They are characteristic constituents of the earth's crust which are not destroyed or degraded. They have widely varied in their chemical and biological functions (Ismail *et al*., 2014). However, severity and levels of pollution of heavy metals differ from place to place. Some metals are important and they are essential for human health. Their deficiency may lead to death and some are beneficial in low concentration but toxic in high concentration. Some are xenobiotics they have no helpful part in the body working. (Lombi *et al*., 2001). Excess level of heavy metals are exposed into environment by means of various sources like industrial waste, fertilizers, use of insecticides, irrigation with waste water, mining activity, application of sewage sludge to agriculture farms filed that has past application of waste water or municipal sludge or in a areas downwind from industrial site (Robert. 2010).

Excess accumulation of heavy metals in soil is very toxic and cause serious threats to living life including animals and as well as pants also. Exposure to heavy metal for a long period of time is very chronic (Ojowao *et al*., 2015). Heavy metals also have dramatic effects on the heath of humans which lead to numerous complications like these are cancer causing and increase the danger of melanoma including colon, kidney, skin, bladder, lungs, liver. They also damage our pulmonary pathway, nasal and paranasal sinuses and also lead to skeletal damage (Ismail *et al*., 2014) also cause mental and intelligence problems, pink disease, fever, diarrhea, anemia, vomiting, disturb metabolism and also cause lead to death (Duruibe *et al*., 2007).

Recently there has being a great interest in developing an effective and environment friendly technology involving the removal of heavy metals from different contaminated places including soil and water (Ali *et al*., 2013). There are several plants including terrestrial and aquatic (submerged, emerged and free floating) have been used to remove heavy metals from different soil and water contaminated places (Ojoawo *et al*., 2015). This method mainly depends on the plants ability to uptake, degrade, extract, immobilize or metabolize to less toxic substances. The degradation, uptake and accumulation of contaminants differ from plant to plant (Ali *et al*., 2013).

This technology has many advantages, beneficial in that way because it is inexpensive, natural, conserves soil resources, has no secondary contaminations and enhances the soil quality and productivity. (Kokyo *et al*., 2014).

This study is illustrating the phytoremediation potential of various aquatic plants for the remediation of different metals from aqua contaminated sites.

II. MATERIAL AND METHOD

The study was conducted to find out the phytoremediation potential of major aquatic plants from different aqua contaminated sites of district Sargodha i.e., S1 (Bhalwaal, Bhehra), S2 (Sargodha, Shahpur), S3 (Silanwali, Sahiwaal).

The map of district Sargodha

A. Sample collection (plants)

Plant samples were collected from all three sites for analysis. Each sample comprised over three replicates. Each sample was randomly handpicked, wrapped in a specific brown envelope, labeled and brought to the Department of Botany, University of Sargodha, Sargodha for further analysis.

B. Elemental analysis (mg/kg)

Elemental analysis was carried out by according to the method (AOAC 1998). Following Metals were studied using standard methods which includes cadmium (Cd), stannous (Sn), antimony (Sb), cobalt (Co), copper (Cu), molybdenum (Mo), nickle (Ni), lead (Pb), mercury (Hg), chromium (Cr), silver (Ag), arsenic (As), manganese (Mn), iron (Fe) and zinc (Zn).

C. Digestion of fruit samples

The oven dried fruit samples were grinded into fine powder and then digested by a wet digestion method. 0.5 g of samples were taken into the digestion flask, after it than add10ml HNO3 in each sample and kept it for overnight. Then the process of digestion was carried out on a hot plate by adding 5ml Perchloric acid in the sample. The process was repeated until the sample solution becomes transparent. Then added distilled water to make the solution up to 100 ml was added to make 50 ml final solution and placed for analysis. Then standard solutions were formulated and with the help of those standards the digested samples were ready for elemental analysis.

For elemental analysis, the filtered solution samples were loaded to the atomic absorption spectrophotometer. Standard curve for each metal prepared by running samples. The elemental contents of the samples were estimated by standard curve prepared for each metal (Ghani et al., 2017).

D. Statistical analysis

Statistical analysis was carried out by using Microsoft Excel 2007. (Steel et al., 1997).

III. RESULTS

Results of the study showed that maximum phytoaccumulation potential for Sb (1.25 mg/Kg), Co (2.43 mg/Kg), Cu (5.33 mg/Kg), Mo (2.27 mg/Kg), Pb (2.06 mg/Kg) was measured in P4 while for Ni (17.33 mg/Kg), Hg (1.60 mg/Kg), Cr (1.42 mg/Kg) and As (0.38 mg/Kg) was observed in P3. However, the highest mean value (phytoaccumulation potential) for Sn (87.62 mg/Kg), Ag (0.39 mg/Kg) and Cd (1.59 mg/Kg) was noted in P1 and P5 respectively.

Results of the study showed that lowest phytoremediation potential for Sb (0.49 mg/Kg), Co (1.23 mg/Kg), Ni (8.77 mg/Kg), Hg (0.58 mg/Kg) was measured in P1 while for Ag (0.17 mg/Kg), As (0.0058 mg/Kg) and Cd (0.21 mg/Kg), Sn (12.29 mg/Kg), Cu (1.95 mg/Kg) was detected in P2 and P3 respectively. However, the Lowest mean value (Phytoremediation potential) for Mo (0.54 mg/Kg), Pb (0.29 mg/Kg) and Cr (0.31 mg/Kg) was experienced in P4 and P5 respectively.

Mean value for Mn, Fe, Zn was ranged from 5.43 mg/Kg (P2) to 0.66 mg/Kg (P1), 179.11 mg/Kg (P2) to 108.62 mg/Kg (P1), 31.50 mg/Kg (P2) to 11.37 mg/Kg (P1) respectively which is shown below in the tables.

Table 1. Comparison of means regarding elemental profile in major aquatic plants collected from different aqua contaminated sites of district Sargodha.

Plants	Sites	Cd (mg/kg)	Sn (mg/kg)	Sb (mg/kg)	Co (mg/kg)	Cu (mg/kg)	Mo (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Cr (mg/kg)	Ag (mg/kg)	As (mg/kg)
P1	S1	0.17±0.01	87.86±0.06	0.08±0.04	1.39±0.14	2.12±0.12	0.52±0.04	8.46±0.21	0.50±0.07	0.88±0.03	0.28±0.06	0.32±0.04	0.04±0.002
	S2	0.42±0.05	87.64±0.06	0.08±0.09	1.16±0.19	2.66±0.14	0.88±0.10	6.37±0.14	0.28±0.06	0.45±0.07	0.49±0.11	0.73±0.02	0.13±0.01
	S3	0.27±0.02	87.35±0.03	1.33±0.03	1.14±0.11	2.37±0.25	0.39±0.03	11.49±0.17	1.17±0.02	0.42±0.02	0.91±0.04	0.12±0.04	0.04±0.004
P2	S1	0.69±0.07	50.41±0.96	2.17±0.17	2.45±0.15	5.84±0.23	3.47±0.12	10.51±0.31	1.76±0.12	1.73±0.0031	1.68±0.08	0.22±0.010	N.D
	S2	0.36±0.02	53.42±1.03	1.37±0.23	1.34±0.09	4.63±0.14	2.52±0.13	10.51±0.56	1.18±0.14	1.43±0.0004	1.22±0.06	0.20±0.008	0.01±0.0021
	S3	0.30±0.04	40.19±1.50	0.22±0.31	3.50±0.14	5.51±0.11	0.82±0.04	14.36±0.32	3.26±0.12	0.36±0.0034	0.97±0.05	0.11±0.012	0.01±0.0015
P3	S1	0.33±0.01	16.17±0.66	1.16±0.02	1.60±0.04	2.53±0.10	0.78±0.11	13.34±0.01	0.66±0.01	1.76±0.02	0.65±0.06	0.15±0.03	0.29±0.08
	S2	0.16±0.02	12.44±0.33	0.89±0.07	1.12±0.09	1.68±0.15	1.21±0.09	17.19±0.02	1.06±0.02	1.50±0.01	1.71±0.16	0.21±0.02	0.79±0.18
	S3	0.15±0.03	8.26±0.29	0.44±0.08	2.62±0.06	1.64±0.23	1.87±0.12	21.45±0.15	0.61±0.01	1.53±0.04	1.90±0.06	0.48±0.05	0.06±0.03

P4	S1	0.25±0.04	22.47±0.61	1.20±0.12	1.51±0.08	2.86±0.05	0.56±0.05	14.11±0.14	0.75±0.03	1.11±0.07	0.75±0.02	0.32±0.10	0.28±0.02
	S2	0.36±0.02	24.57±0.55	1.80±0.04	1.31±0.17	2.49±0.07	0.31±0.03	17.92±0.50	0.04±0.03	1.41±0.13	0.87±0.03	0.32±0.02	0.05±0.03
	S3	0.54±0.06	16.54±0.81	0.51±0.15	2.40±0.13	1.63±0.14	0.76±0.02	11.59±0.62	0.08±0.04	0.44±0.10	1.67±0.10	0.05±0.03	0.11±0.01
P5	S1	2.51±0.07	24.24±0.49	1.36±0.06	1.16±0.05	4.62±0.32	1.05±0.16	17.25±0.84	0.79±0.06	1.16±0.001	0.23±0.01	0.23±0.01	0.15±0.04
	S2	1.84±0.06	22.47±0.25	1.07±0.04	1.04±0.01	3.32±0.34	0.90±0.08	19.14±0.81	0.41±0.01	1.31±0.006	0.30±0.06	0.52±0.08	0.16±0.01
	S3	0.43±0.13	0.813±0.46	0.80±0.11	2.30±0.02	3.91±0.14	0.61±0.02	11.29±0.71	1.03±0.03	0.71±0.003	0.40±0.06	0.12±0.03	0.01±0.002

IV. DISCUSSION

Results regarding phytoremediation by Carex haydenii are in collaboration with the findings of (Jamnicka et al., 2013). Their findings showed that Carex is a good potential phytoremediator plant for the phytoremediation of Cu, Zn, Cd and Pb. Elemental analysis of Carex showed that these plants can absorb Cu ranged from 7.15 mg/Kg to 8.78 mg/Kg from in polluted area while from polluted area, it can able to absorb Cu ranged from 13.06 mg/Kg to 10.41 mg/Kg. Accumulation of Zn was ranged from 53.12 mg/Kg to 56.04 mg/Kg, while from polluted area, its phytoremediation ranged from 69.89 mg/Kg to 120.65 mg/Kg. Carex also a good potential phytoremediator plant for those aqua contaminated sites in which Co, Ni also present is access ranged from 0.01 mg/Kg to 0.67 mg/Kg. Noted results also indicate that phytoremediation for Cd was ranged from 0.26 mg/Kg to 4.15 mg/Kg. Phytoremediation potential for was ranged from 2.78 mg/Kg to 9.62 mg/Kg. In Gallium, ranged from 2.70 mg/Kg to 3.97 mg/Kg. In Dentaria, ranged from 3.45 mg/Kg to 6.09 mg/Kg. Variation in concentration was main attributed to presence of metals in the water.

Results regarding phytoremediation of Typha angustifolia are in collaboration with the findings of (Chandra et al., 2010). Their findings indicate that Typha is a potential plant for the phytoremediation of Cu, Pb, Ni, Mn and Zn with a range from 100 to 800 mg/L.

Results regarding phytoremediation by Lemna species are in collaboration with the findings of (Zayed et al., 1997). Their findings showed that Lemna are also a good/potential phytoremediator plants for the phytoremediation of aqua contaminated sites especially contaminated with heavy metals. Their findings indicate that Lemna plants are able to phytoremediate Cd, Cr, Cu, Ni, Pb and Se more efficiently from different aqua contaminated sites, but findings also indicate that highest concentration of each trace element accumulated in duckweed tissues were 13.30 g/Kg for Cd, 4.27 g/Kg for Se, 3.36 g/Kg for Cu, 2.87 g/Kg for Cr, 1.79 g/Kg for Ni and 0.63 g/Kg was noted for Pb. Sometime duckweeds showed some symptoms of toxicity if too much high concentration of these metals were present in water like reduced growth, chlorosis. Variation in phytoremediation for metals in duckweeds was may attributed to level of contamination present in water.

Results regarding phytoremediation by Phragmites are in collaboration with the findings of (Ahmad et al., 2013). Their findings indicate that Phragmites are potential phytoremediator plants for the phytoremediation of Al, Mn, Zn, Cu, Mo, Co, Cu, Cr, Cd and Ni. He also observed the ratio of accumulation of metals in roots to shoots. Their findings indicate that Phragmites species are able to accumulate metals more in roots as compared to shoots and leaves. Different Phragmite plants are used for phytoremediation of different metals like Phragmites australis is potential phytoremediator for Al, Mn, Ba and Phragmites communis is a good potential phytoremediator for Z, Pb, Cd, Cr, Co, Ni. Variation in phytoremediation for metals in Phragmites may be due to environmental factors or may be due to availability of contaminations present on aqua sites.

V. CONCLUSION

All observed plants have good phytoremediation potential for heavy metals at aqua contaminated sites but there is fluctuation in phytoaccumulation of metals is present in all plants even in the same plants collected from same as well as from different sites which may attributed to different environmental conditions or may attributed to sources of contaminations or may be due to water composition mean which type of contaminants (heavy metals) are present or may attributed to absorbance rate of metals by plants and contact between metals and plants as well as level of toxicity and toxic effects on plants.

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Table 1. Comparison of means regarding elemental profile in major aquatic plants collected from different aqua contaminated sites of district Sargodha.

Plants	Sites	Cd (mg/kg)	Sn (mg/kg)	Sb (mg/kg)	Co (mg/kg)	Cu (mg/kg)	Mo (mg/kg)	Ni (mg/kg)	Pb (mg/kg)	Hg (mg/kg)	Cr (mg/kg)	Ag (mg/kg)	As (mg/kg)
P1	S1	0.17±0.01	87.86±0.06	0.08±0.04	1.39±0.14	2.12±0.12	0.52±0.04	8.46±0.21	0.50±0.07	0.88±0.03	0.28±0.06	0.32±0.04	0.04±0.002
	S2	0.42±0.05	87.64±0.06	0.08±0.09	1.16±0.19	2.66±0.14	0.88±0.10	6.37±0.14	0.28±0.06	0.45±0.07	0.49±0.11	0.73±0.02	0.13±0.01
	S3	0.27±0.02	87.35±0.03	1.33±0.03	1.14±0.11	2.37±0.25	0.39±0.03	11.49±0.17	1.17±0.02	0.42±0.02	0.91±0.04	0.12±0.04	0.04±0.004
P2	S1	0.69±0.07	50.41±0.96	2.17±0.17	2.45±0.15	5.84±0.23	3.47±0.12	10.51±0.31	1.76±0.12	1.73±0.0031	1.68±0.08	0.22±0.010	N.D
	S2	0.36±0.02	53.42±1.03	1.37±0.23	1.34±0.09	4.63±0.14	2.52±0.13	10.51±0.56	1.18±0.14	1.43±0.0004	1.22±0.06	0.20±0.008	0.01±0.0021
	S3	0.30±0.04	40.19±1.50	0.22±0.31	3.50±0.14	5.51±0.11	0.82±0.04	14.36±0.32	3.26±0.12	0.36±0.0034	0.97±0.05	0.11±0.012	0.01±0.0015
P3	S1	0.33±0.01	16.17±0.66	1.16±0.02	1.60±0.04	2.53±0.10	0.78±0.11	13.34±0.01	0.66±0.01	1.76±0.02	0.65±0.06	0.15±0.03	0.29±0.08
	S2	0.16±0.02	12.44±0.33	0.89±0.07	1.12±0.09	1.68±0.15	1.21±0.09	17.19±0.02	1.06±0.02	1.50±0.01	1.71±0.16	0.21±0.02	0.79±0.18
	S3	0.15±0.03	8.26±0.29	0.44±0.08	2.62±0.06	1.64±0.23	1.87±0.12	21.45±0.15	0.61±0.01	1.53±0.04	1.90±0.06	0.48±0.05	0.06±0.03
P4	S1	0.25±0.04	22.47±0.61	1.20±0.12	1.51±0.08	2.86±0.05	0.56±0.05	14.11±0.14	0.75±0.03	1.11±0.07	0.75±0.02	0.32±0.10	0.28±0.02
	S2	0.36±0.02	24.57±0.55	1.80±0.04	1.31±0.17	2.49±0.07	0.31±0.03	17.92±0.50	0.04±0.03	1.41±0.13	0.87±0.03	0.32±0.02	0.05±0.03
	S3	0.54±0.06	16.54±0.81	0.51±0.15	2.40±0.13	1.63±0.14	0.76±0.02	11.59±0.62	0.08±0.04	0.44±0.10	1.67±0.10	0.05±0.03	0.11±0.01
P5	S1	2.51±0.07	24.24±0.49	1.36±0.06	1.16±0.05	4.62±0.32	1.05±0.16	17.25±0.84	0.79±0.06	1.16±0.001	0.23±0.01	0.23±0.01	0.15±0.04
	S2	1.84±0.06	22.47±0.25	1.07±0.04	1.04±0.01	3.32±0.34	0.90±0.08	19.14±0.81	0.41±0.01	1.31±0.006	0.30±0.06	0.52±0.08	0.16±0.01
	S3	0.43±0.13	0.813±0.46	0.80±0.11	2.30±0.02	3.91±0.14	0.61±0.02	11.29±0.71	1.03±0.03	0.71±0.003	0.40±0.06	0.12±0.03	0.01±0.002