Application of aquatic plants for the remediation of organic chlorine pesticides in keenjhar lake, Pakistan

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INTRODUCTION:

Organochlorine pesticides are one of the most extensively used agrochemicals for long. They were mostly used for agriculture and in mosquito, termite control programs *(W*ANG et al., *2007)*. OC pesticides have low aqueous solubility and lipophilic properties, which enables it to ingest in the food chain posing health hazard and threats to environment *(Sarkar et al., 2008)*. Many metabolites of OC, pesticides are stable in environment with longer half-lives. Many studies have shown that DDT and its derivatives are still found in the highest concentration*(Singh & Singh, 2017)*.

Recent research has indicated the presence of OC pesticides and it's derivate in water, vegetation, sediment and biota of many regions across the world. Its stability and endurance in the environment through air, water and food cause chronic toxicity in human and animals *(Barnhoorn et al., 2015; Łozowicka et al., 2016; Wu et al., 2015; Yang et al., 2015)*.

OC pesticides should transform into non-toxic form because of its persistent nature and biodegradability. A number of conventional technologies have been used to remove OC pesticides contamination, each have its benefits and limitations *(Gomes et al., 2012; Ikehata et al., 2008)*. To treat waste water in an economical and environmental friendly way the method of phytoremediation is widely used.

TABLE 1:

Level of Organochlorine Pesticide in the Water Samples of Keenjhar Lake

OCP	Mean ppb	SD	Range	Percentage
Alpha-BHC	0.642	0.843	0.12-0.27	24
Beta-BHC	0.777	0.667	0.26-0.53	13
Gamma-BHC	6.874	13.277	0.10-2.27	30
Delta-BHC	0.832	0.226	0.00-0.02	74
Heptachlor	0.361	0.565	0.006-0.280	2
Aldrin	0.737	1.o38	0.030-0.899	82
DDE	2.932	6.138	0.168-3.710	94
DDT	0.697	1.059	0.036-0.487	69

Keenjhar Lake is the biggest fresh water lake in the province of Sindh. It is located at 113 kilometers ahead from Karachi, about 19 kilometers north and north east of Thatta District. It is the source of fresh water for many areas of Karachi, Thatta and Keti Bander *(M Zaheer Khan et al., 2015).*

Many adverse health effects like endocronic disruption, birth defects, immune system dysfunction and Cancer have been notified as effect of OC pesticides and its metobilities *(Ejaz et al., 2004*). This work therefore, focuses on the remedial technique of phytoremediation with the inoculation of a consortium to increase system efficiency.

MATERIAL AND METHODS:

Samples of water and sediments were collected from various sites namely, Inlet of the lake, recreational point 1 and 2, Horolo drain, Nooriabad drain and outlet of the lake Keenjhar. Sampling was done seasonally from summer to spring 2019 following the guidelines US-EPA (*US-EPA, 2000*). Samples were collected from surface of the lake and sediments. Amber glass bottles were used to collect water samples and store in an ice-chest at 4◦C and transferred to laboratory for analysis (*Kafilzadeh, 2015*).

On the basis of studied efficiencies to native plants namely water hyacinth and silvini molesta were selected for the remediation process *(Harikumar et al., 2013; Mercado-Borrayo et al., 2015*) .These plants, before processing were brought to laboratory and washed with de-ionized water to remove its contamination. These plants were left in clean water pots for two weeks for the process of acclimatization and were separated on the basis of similarities in size/number of leaves/stems (*Huma Bukhari, 2016*).

EXPERIMENTAL SETUP:

Pot experiment was performed for the phytoremediation of lake water. Two sets of six glass pot containing 25 liters of water in each pot from the lake was setup along with plants. Three pots in each set were inoculated with a consortium. The temperature fluctuation was 32◦C to 41◦C, sunlight of 8 hours was given to the pots and distilled water was used to compensate evaporation losses. The samples were taken at 3^{rd}, 7^{th}, 11^{th} and 15^{th} day after transplanting for extraction (*Gbeddy et al., 2014*).

EXTRACTION OF OC PESTICIDES FROM WATER SAMPLE:

Extraction process was performed in the laboratory using liquid-liquid extraction. The water was initially filtered with 70mm whatman paper and then poured (800ml) in seperatory funnel, adding 100ml of an-hexane and dichloromethane (1:1 v/v) was mixed and shake for 2 to 3 minutes. A typical glass funnel containing 20 grams of anhydrous sodium to intake organic phase. This process was repeated 2 times (*US EPA, 2007*).

EXTRACTION OF OC PESTICIDES FROM PLANTS AND SEDIMENTS:

To achieve constant weight, the samples of plants and sediment for the pot experiment were first dried and sieved to less than 1mm. The sample of each plant was converted into a powdered form having weight around 0.25 grams were than kept in a filter paper and sent to a soxhlet extractor for further processing. The samples were extracted with 150ml of dichloromethane and an-hexane (20 : 80 at 50 ◦C) it was than processed in a gas chromatograph.

RESULTS AND DISCUSSION:

Keenjhar Lake is a fresh water reservoir and ramsar site facing water quality degradation due to natural and anthropogenic activities(*Farha Aziz et al., 2015*) . The lake receives industrial effluent from Nooriabad and Kotri Industrial zones including some non-point sources as agriculture. This all leads to chemical load in the fresh water lake.

The physiochemical parameters from initiation till the final day of collection are illustrated below in the table. The water quality was improving but the PH of the pots with consortium was relatively higher.

TABLE 2:

Physio-Chemical Parameters of Keenjhar Lake

Parameter	Day 1	Day 3	Day 7	Day 11	W.H.O. standards
pH	7.76	7.9	8.05	9.1	6.5-8.5
Total Organic Carbon (mg/L)	9.42	9.79	10	15	< 4
total nitrogen (mg/L)	0.954	0.943	0.925	0.875	
electrical conductivity (Ω/cm)	1351.75	1215	1113.75	952	500
dissolved oxygen (mg/L)	8.09	10.2	11.93	11.93	7.5
Total Dissolve Solids (mg/L)	1008	858	769	700.5	<1000
Chemical Oxygen Demand (mg/L)	18	16	20	25	
Temperature C	36°	35°	42°	40°	

TREATMENT RESULTS OF POTS WITHOUT CONSORTIUM:

The above bar graph shows that there was a gradual decrease in compounds. The least concentration was found that of Heptachlor with a mean concentration of 0.11±0.23, that was treated with water hyacinth. Overall, water hyacinth proved to be more efficient than silvania molesta

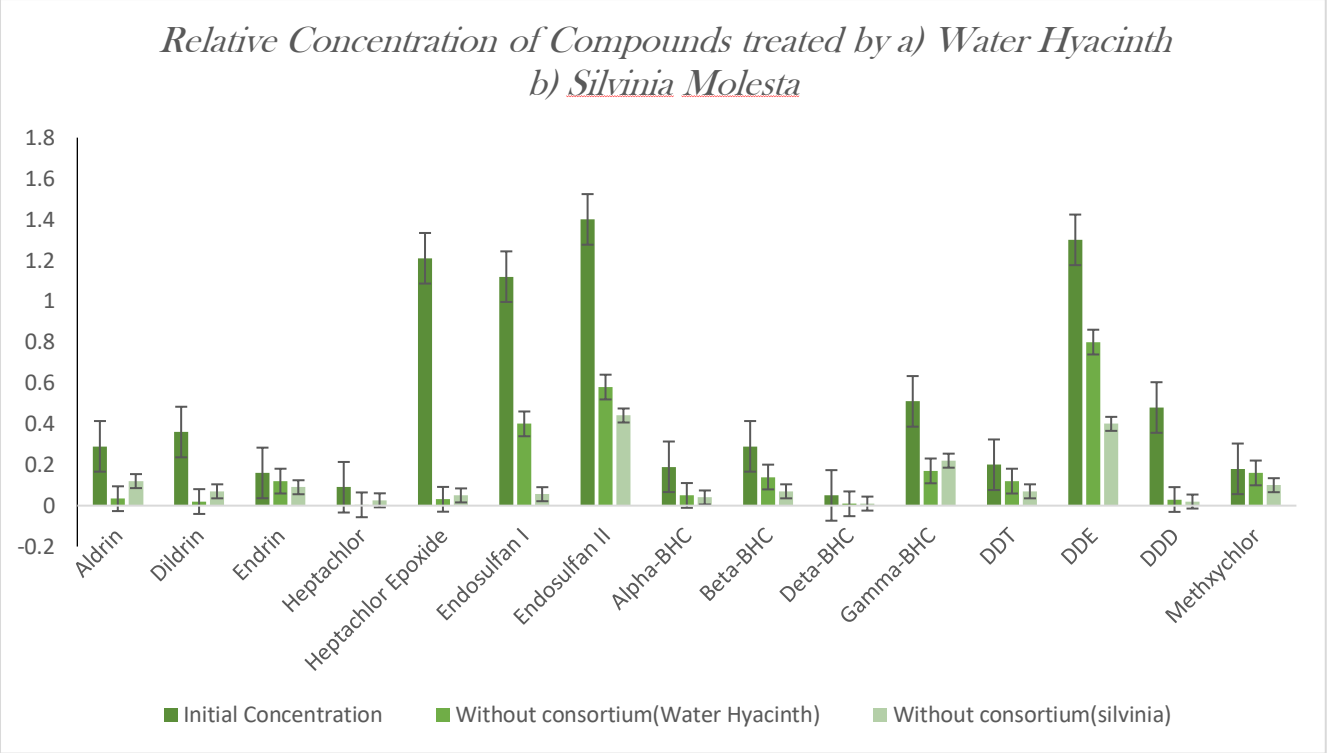

Fig:1 ***Relative Concentration of Compounds treated by a) Water Hyacinth b) Silvinia Molesta***

TREATMENT RESULTS OF POTS WITH CONSORTIUM:

There was a rapid fall observed in the concentration of drin family i.e Aldrin, dieldrin and endrin respectively. DDT and Heptachlor with the concentration of 0.18 ± 0.13, 0.23 ± 0.18, 0.13 ± 0.09, 0.05 ± 0.04. Salvania molesta proved more efficient then water hyacinth in the above findings.

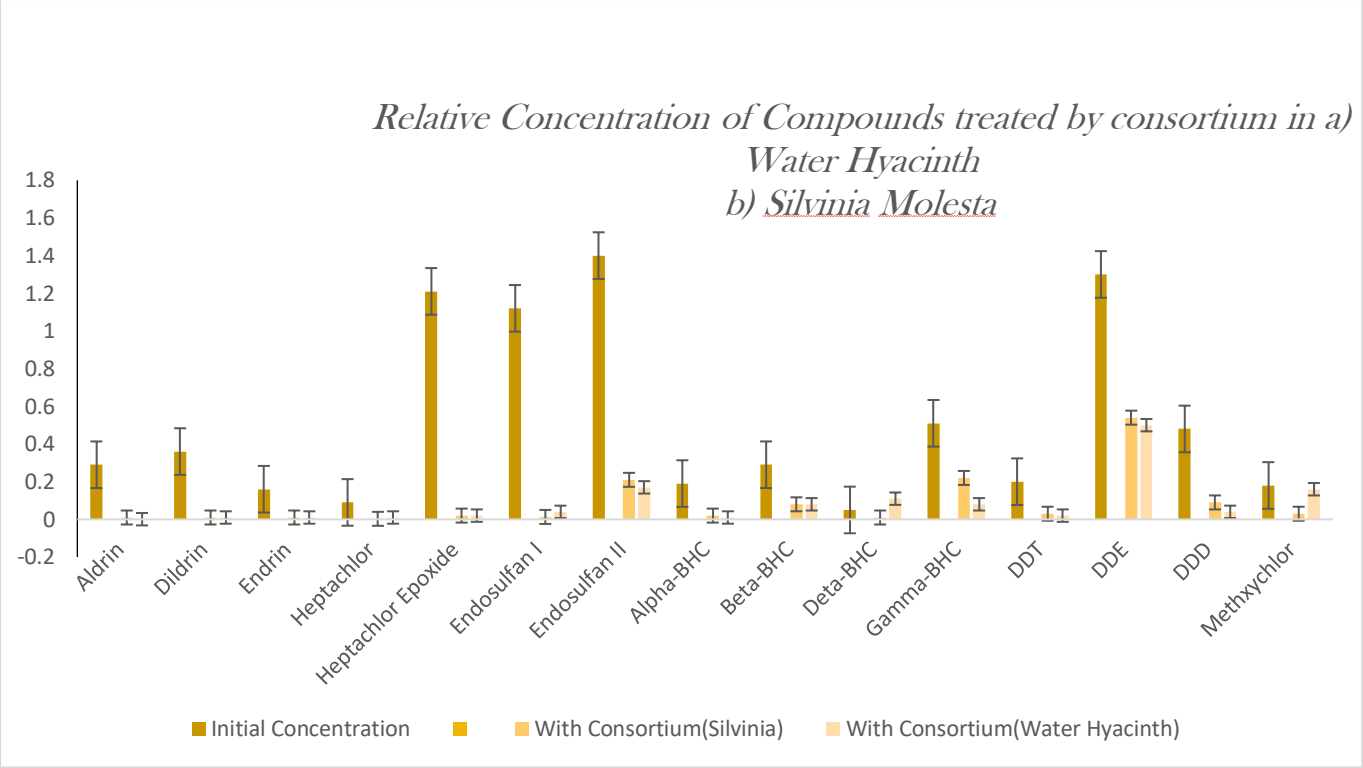

Fig 2: Relative Concentration of Compounds treated by consortium in a) Water Hyacinth b) Silvinia Molesta

CONCENTRATION OF OCP IN SEDIMENTS:

There was no significant difference observed in the concentration of OCP in sediments. The difference was notified in pots water hyacinth rather than pots with Silvania molesta. The reason behind this can be length of roots because between two plants water hyacinth have long roots as compared to silvania with short roots.

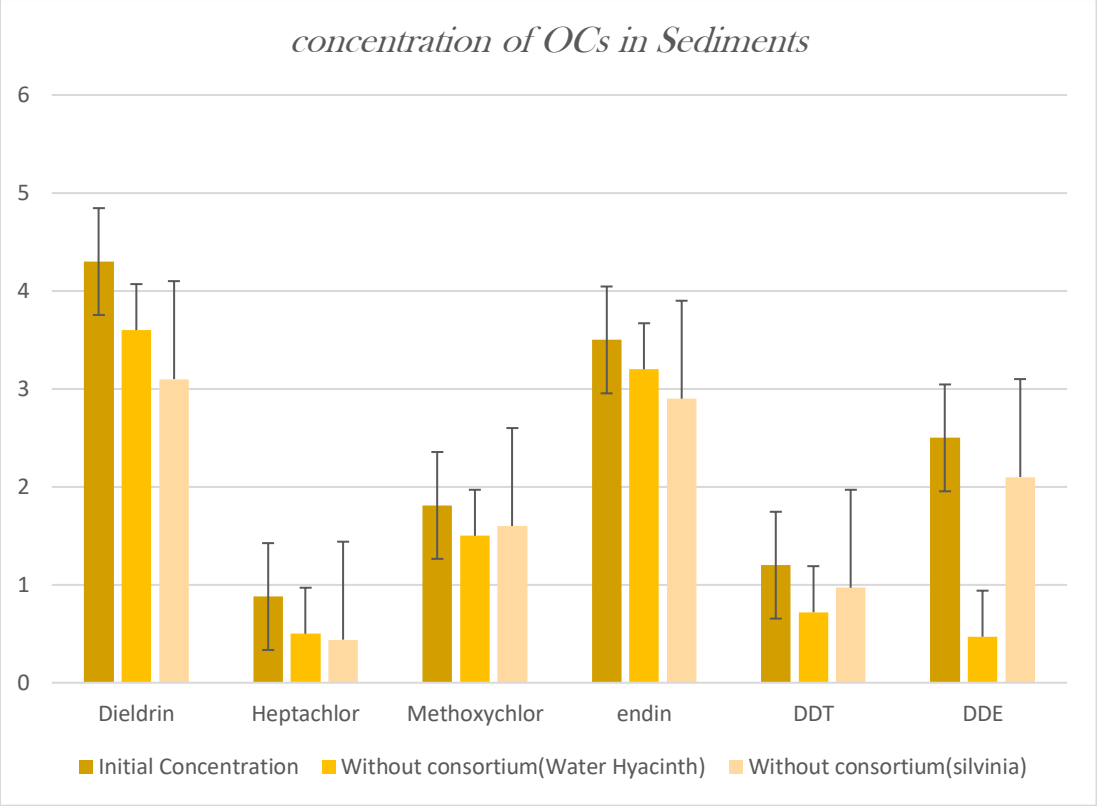

Fig: 3 Concentration of Organochlorine pesticides in sediment of pots without consortium

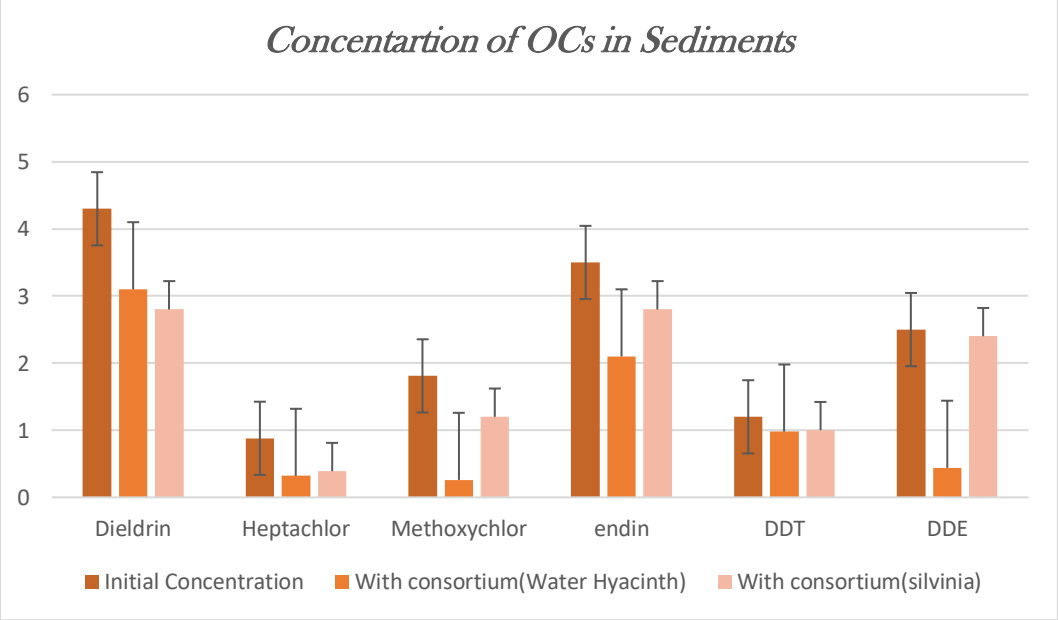

Fig: 4 Concentration of Organochlorine pesticides in sediment of pots with consortium

BIOACCUMUATION RATE OF PLANTS:

The bioaccumulation rate was notified more in water hyacinth without added a consortium. The highest rate was observed in Endosulfan and Endrin by 75% to 70%.

With consortium the relative change was different. Endrin and Heptachlor showed maximum change by uptake of 60% to 70% respectively.

Bioremediation is a promising technique but more studies are still required. This study show that water is more efficient bio accumulator as compared to silvinia molesta. The quantitative reduction/ decrease in OC of treated water during the experiment were not fully compliment to the total OC uptake by the plant species.

ACKNOWLEDGEMENT:

This study was funded by US-Pakistan Centre for Advance Studies in Water from Mehran University of Engineering and Technology Jamshoro, Pakistan

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