Journal homepage
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Anbar Journal of Agricultural Sciences
(University of Anbar – Agriculture College)

HEAVY METALS AND CONTAMINATION PARAMETERS REMOVAL BY DIFFERENT PLANT FROM WASTEWATER IN HYBRID CONSTRUCTED WETLANDS

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Article info

Received: 2021-02-03
Accepted: 2021-08-13
Published: 2021-12-31

DOI -Crossref:
10.32649/ajas.2021.175871

Cite as:
Salh, Q. K., K. T. Muhammad, and K. A. Rashid. (2021). Heavy metals and contamination parameters removal by different plant from wastewater in hybrid constructed wetlands. Anbar Journal of Agricultural Sciences, 19(2): 169–181.

Abstract

Water is essential requirement for every living creature on our planet to grow and prosper. The progress expansion and increased population of Sulaimani city caused increased in water demand and need for reusing of waste water for irrigation. This study aims to remove some waste water heavy metals and parameters by root and shoot of Macrophytes in Hybrid Constructed wetlands (HCW). HCW are designed as (Vertical-Horizontal and Horizontal-Vertical) along with sand filtration implemented with two local Macrophytes (*Typha angustifolia* and *phragmate australis*). The plant root and shoot were analyzed in beginning and end of the study to determine the removal rate.

The result shows increase in the mean concentration values of heavy metals and waste water parameters in root and shoo of both *T. angustifolia* and *Ph. australis* in HCW (H&V) and (V&H). Therefore, Macrophytes in HCW can be used to remove heavy metals and other parameters from waste water used for irrigation.

Keywords: Removel, Heavy metal, Parameters, Wastewater, Macrophytes, Wetland.

ازالة العناصر الثقيلة والملوثات الاخرى من مياه الصرف الصحي باستخدام نباتات مختلفة في احواض الصرف الصحي التركيبية

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الخلاصة

الماء هو ضرورة أساسية لكل كائن حي على كوكبنا لكي ينمو ويزدهر. ان التوسع الحضاري في مدينة السليمانية وزيادة عدد سكانها ادت إلى زيادة الطلب على المياه والحاجة إلى إعادة استخدام مياه الصرف الصحي للري. تهدف هذه الدراسة إلى إزالة بعض المعادن الثقيلة ومعايير مياه الصرف الصحي عن طريق الجذر والجزء الخضري للنباتات الكبيرة النامية في الأراضي الرطبة الهجينة HCW تم تصميم HCW على اتجاه عمودي – أفقي وأفقي– عمودي على طول المرشح الرملي مع اثنين من النباتات الكبيرة المحلية (Typha angustifolia وPhragmate australis) تم تحليل جذر النبات والجزء الخضري في بداية الدراسة ونهايتها لتحديد معدل الإزالة.

اظهرت النتائج زيادة في معدل قيم تراكيز المعادن الثقيلة ومعاملات مياه الصرف في الجذر والجزء الخضري لكل من T. angustifolia وPh. australis في HCW (H&V) و(V&H) ولذا، يمكن استخدام Macrophytes في HCW لإزالة المعادن الثقيلة والبارامترات الأخرى لمياه الصرف المستخدمة في الري.

كلمات مفتاحية: فروج اللحم، برامج التغذية، قطعيات الذبيحة، التركيب الكيمياوي لقطعيات الذبيحة.

Introduction

Water is essential for maintaining, an adequate food supply and productive environment for the human population, animals, plants, and microbes (9). The choice for wastewater treatment systems will vary in relation to the pollutant to be removed. Constructed wetlands (CWs) for the purpose of wastewater treatment, also called treatment wetlands, can be defined as engineered or manmade systems that utilize wetland plants, sediments and their associated microbial assemblages to treat an effluent or other water sources, almost every type of constructed wetlands can be combined to fit different types of wastewater. However, hybrid systems are comprised most frequently of vertical flow and horizontal flow systems arranged in a staged manner (27). Macrophytes are a natural part of healthy aquatic ecosystems and are beneficial in many ways. They produce oxygen through the process of photosynthesis (4). Biological filtration is a best way in wastewater treatment; Aquatic macrophyte systems can be effectively used to reduce pollutant levels in water bodies (22).

Wastewater is still used in many areas of Kurdistan region including Sulaimani province. The presence of heavy metals in wastewater causes a serious health problem (18, 23). The in growing population Sulaimani province does not only yield more wastewater but also increases demand for cleaner water at least for irrigation purposes. This study assessed the capability of macrophytes in absorbing some heavy metals and other parameters of wastewater using two different hybrid constructed wetlands.

The term heavy metals is applied to the group of metals and semimetals (metalloids) that have been associated with contamination and potential toxicity or ecotoxicity; it usually refers to common metals such as copper, lead, or zinc. However, the term is only loosely defined and there is a specifice defination for them (2). Common heavy metals include zinc (Zn^{+2}), copper (Cu^{+2}), lead (Pb^{+2}, Pb^{+4}), cadmium (Cd^{+2}), mercury (Hg^{+1}, Hg^{+2}), chromium (Cr^{+2}), nickel (Ni^{+2}), tin (Sn^{+2}, Sn^{+4}), arsenic (As^{-3}, As^{+}, As^{+5}), and silver (Ag^{+1}). Some metals are important as micronutrients to living cells (Fe^{+2}, Mo^{+4}, $Mn^{+2)}$. Even some that are useful to living cells can be toxic above trace levels (Zn^{+2}, Ni^{+2}, Cu^{+2}, and Cr^{+2}) (19). Metals that are essential to plant function can become toxic at high enough levels conversely (10).

A study evaluated the toxic levels of some heavy metals such as (Pb^{+2}, Pb^{+4}, Cd^{+2}, Ni^{+2}, and Cu^{+2}) in soil and wastewater used for irrigation of some vegetables in Duhok City, concluding that the irrigation wastewater was heavily contaminated by those metals (15). (17) Astudy was to evaluate the toxic levels of some heavy metals such as (Fe^{+2}, Mn^{+2}, Zn^{+2}, and Cu^{+2}) in wastewater and treatment wastewater by the plants for irrigation purposes in Sulaimani City. The plants selected for this study two species most commonly used in constructed wetland Cattail (*Typha sp.)* and Reeds (*Phragmites sp.)* were considered as standard plants for constructed wetlands typically and commonly used in tropical {high latitude (cold/boreal)}and {mid-latitude (temprate)} climates worldwide (12). (12) used some species macrophyte such as Cattail (*Typha sp.)* for irrigation purposes in Sulaimani City. Dietary exposure to heavy metals, namely cadmium (Cd^{+2}), lead (Pb^{+2}, Pb^{+4}), zinc (Zn^{+2}) and copper (Cu^{+2}), has been identified as a risk to human health through the consumption of vegetable crops (12).

The main objectives of the present study are to compare the accumulation rates of heavy metals and some parameters of wastewater in root and shoot of Macrophyte using two-stage subsurface constructed wetland {Vertical Sub-Surface Flow (VSSF) + Horizontal Sub-Surface Flow(HSSF) filter) and {Horizontal Sub-Surface Flow(HSSF)+ Vertical Sub-Surface Flow (VSSF) filter}.

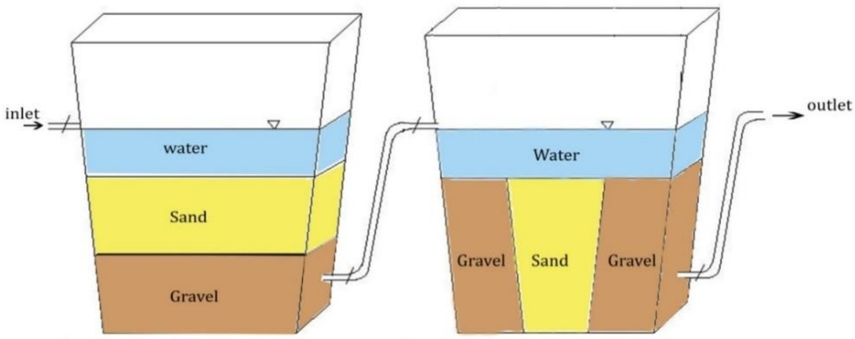
One essential structural component in these ecosystems is the plant vegetation which performs a number of important functions in wetlands. Aquatic plants used in subsurface wetlands are Cattail (*Typha sp.)* and reeds (*Phragmites sp.)*.

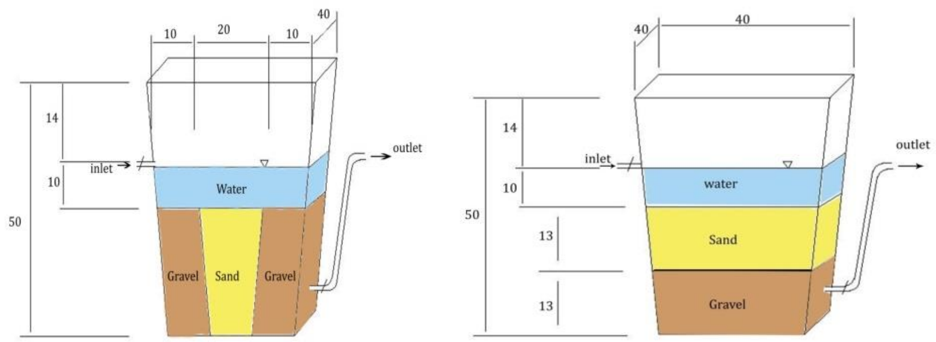
Materials and Methods

Water samples were collected from the influent storage tank and from the wetlands' outlet pipes for analysis. The untreated wastewater, after passing through the sedimentation storage tanks, was treated by hybrid constructed wetlands having macrophyte plants in the different stages of treatment was collected. Wastewater outlet samples in the hybrid constructed wetland at different stages of treatment were taken after stabilization period (52days) the period needed for stabilization, adaptation and grown and the length root in the period different between 4-11 cm, according to regular schedule at biweekly interval periods. After the collection of wastewater samples were brought back to the laboratory kept in cool and dark condition as described by (2), for analysis purposes and for the field analysis, a clean beaker was used for same purposes in the field.

Plant Samples were harvested and transferred to the laboratory in labeled paper bags to prevent the plants from rotting as recommended by (19). The roots and shoots were separated then they were washed with tap water followed by distilled water to remove dust particles. The plants were oven dried at 60°C for 72 hours, to stabilize the samples and to facilitate particle size reduction, homogenization and weighed (dry weight) as described by (10). The resultant was grounded with a stainless steel mill then stored for further chemical analysis. The two types of hybrid constructed wetlands contain the sand, gravel and water used to the grown plants (Scheme1).

Hybrid constructed wetland system: New study, two types of hybrid constructed wetlands (HSSF-VSSF and VSSF-HSSF) were used Scheme 1. Two aquatic plants (*T. angustifolia*) local name Laban and (*Ph. australis*) local name Qamishibarek were collected for the project. They were used to accumulate heavy metals and some other parameters of wastewater in the hybrid constructed wetland. After transplantation (6plants per one constructed wetland), the plants were left to stabilization and adaptation for more 50 days, the time required for the adaptation and stabilization of young plants with their new place (26). At the end of the experiment, root, and shoots of the macrophyte samples from the hybrid constructed wetland were collected and taken to the laboratory to be prepared for analysis.





Scheme 1. Schematic diagram of Hybrid constructed wetland (HC).

Analysis of Trace Heavy Metals in Plant Samples: The plant samples were analyzed only for some of the common heavy metals (Fe^{+2}, Cu^{+2}, Cd^{+2} and $Pb^{+2,}$ Pb^{+4}) as an indicator of the severity of water pollution in Sulaimani city. The plant samples were wet digested by a mixture of concentrated sulfuric acid and concentrated hydrogen peroxide as described in (21). A 1.0g plant of each sample was digested with 20 ml mixture of concentrated H_2SO_4 and H_2O_2 of 37% in a ratio of 1:1 at room temperature for 30 minutes. Thereafter, the plants were digested at 350 ˚C for 30 minutes using the Kjeldahl digester (model Buchi Speed Digester K-425/Switzerland). Once the digest became clear, it diluted with distilled water, filtered through an ashes Whatman41 filter, and diluted to 100 ml with excess distilled water, then stored in polyethylene bottles at 4 ℃ for element analysis. The elemental assay was conducted using both inductively coupled plasma-optical emission spectroscopy ICP-OES (model PerkinElmer, precisely Optima 2100/USA).

Statistical analysis: The obtained data from the present work was analyzed statistically following a software program that is known as a statistical package for social sciences and Microsoft Excel professional Edition2007/ Data Analysis. However, analysis of variance (ANOVA) and complete randomized design (CRD) factorial were chosen as the experimental design for analysis purposes (3).

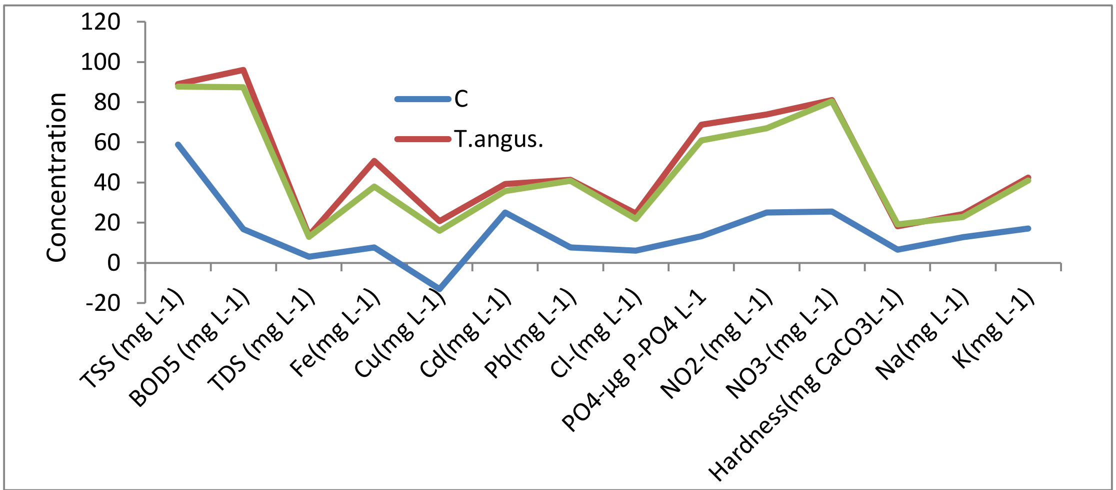


Figure 2. Comparison between control and the effects of the studied Macrophytes at the end stage for V&H hybrid wetland.

Plants having the ability of accumulating heavy metals and other parameters of wastewater have significant influence on our environment (7, 8) and (24). The ion concentration was decreased with the depth which agree with the results obtained by (13) on both Hawler main sewage canal and (17) and Sulaimani sewage canal. This is may be due to removal efficiency of sand which led to an ion blockade because of the filtration process.

Generally, this study shows that concentrations of all nutrients in root and shoot systems for both designs {HCW (H&V and V&H)} except the iron in the {HCW (H&V and V&H)} in the root and shoot system in *T. angustifolia* higher than the *Ph. Australis* as shown in Table1 and Fig 1 and 2.

The macrophytes are able to grow on organic, highly reduced sediments, as well as on acid sites with high concentration of reduced metal ions in the interstitial water (14), and the design {HCW (V&H)} has more increased concentration nutrients comparative to the designs {HCW (H&V)}.

Showed an from Table 2 indicated that of the root system for *T. angustifolia* and *Ph. australis* in HCW showed an increase in the mean values concentrations of (Fe, Cu, Cd and Pb) in both *T. angustifolia* and *Ph. Australis.* From the same table the root system for *T. angustifolia* and *Ph. australis* in HCW showed an increase the mean values concentrations of (Fe, Cu, Cd and Pb) in *T. angustifolia* and in *Ph. Australis*. While the percentage of increase in the concentration is greater for {HCW (V&W)}. When shoot systems for *T. angustifolia* and *Ph. australis* in {HCW (H&V) were analyzed, in table 2 it showed increase in the mean values concentrations of (Fe, Cu, Cd and Pb) in *T. angustifolia* to (85.7, 144.4, 95.1 and 202.4 %) respectively, and in *Ph. australis* to **(**84.6, 60.3, 97.1 and 26.7 %) respectively. While the shoot systems for *T. angustifolia* and *Ph. australis* in {HCW (V&H)} showed an increase the mean values concentrations of (Fe, Cu, Cd and Pb) in *Ph. australis* and *T. angustifolia* to (83.1, 146.9, 100 and 110.7%) and in to (94.7, 62.2, 139.3 and 84.4 %) respectively.

Results and Discussion

The result of removal rates of hybrid constructed wetland from different stages of purification treatment are presented in **(**Table 1) showing lower value of EC in the beginning of the experiment at sediment unit 1.44%, while the highest removal was 14.94% observed for *T. angustifolia* in {HCW (V&H). However, salinity is the most important parameter for determining the suitability of water for agriculture (21). Generally, the results indicate that the removal ability for all parameters in the design {HCW (V&H)} was higher compared with {HCW (H&V)}.

Table 1. Removal rates of pollutant parameters in macrophyte plants at different stages of treatment in hybrid constructed wetlands.

Parameters	Sedimentation		Control HCW(H&V)		*T. angustifolia* in HCW(H&V)		*Ph. australis* in HCW(H&V)		Control HCW (V&H)		*T. angustifolia* in HCW(V&H)		*Ph. australis* in HCW (V&H)	
	15/Jun	1/Sep	15/Jun	1/Sep	15/Jun	1/Sep	15/Jun	1/Sep	1/Jun	1/Sep	1/Jun	1/Sep	1/June	1/Sep
EC ($\mu S\ cm^{-1}$)	1.4	3	1.5	2.9	7.2	13.5	6.8	12.9	2.1	3.2	7.9	14.9	9.7	14.0
TSS ($mg\ L^{-1}$)	22.3	25.9	36.6	58.9	49.4	89.0	47.0	87.7	37.8	61.3	51.2	91.4	50.0	89.6
BOD_5 ($mg\ l^{-1}$)	14.7	15.7	7.6	16.7	27.4	96.1	25.8	87.5	11.3	20.6	33.5	96.2	30.8	90.3
Turbidity (NTU)	42.9	56.2	71.5	59.3	57.9	78.8	55.4	75.2	48.8	60.2	59.5	81.4	57.0	78.8
TDS ($mg\ l^{-1}$)	1.4	2.9	1.9	3.0	7.3	13.6	6.8	13.0	2.2	3.2	8.0	15.0	7.76	14.1
Total hardness (mg $CaCO_3 l^{-1}$)	4.0	4.0	5.3	6.6	11.3	18.2	10.6	19.2	5.5	6.1	11.5	18.7	11.3	19.5
Sodium ($mg\ l^{-1}$)	6.4	6.16	8.2	12.8	11.6	24.3	11.1	22.9	8.8	12.4	8.9	24.8	12.7	23.0
Potassium ($mg\ l^{-1}$)	12.6	9.8	6.5	17.1	11.1	42.4	11.1	41.0	7.8	16.4	11.8	43.1	9.2	43.1
Chloride (Cl^-) ($mg\ l^{-1}$)	13	-1.1	3.7	6.1	12	24.6	9.9	21.9	4	4.6	12.4	24.9	10.3	22.6
(PO_4) ($\mu g\ P\text{-}PO_4\ l^{-1}$)	10.1	10.8	15.8	13.2	49.7	68.8	43.1	60.9	17.1	14.2	53.9	72.9	45.9	65.2
Nitrite (NO_2^-) ($mg\ l^{-1}$)	16.5	18.5	38.3	25	59.3	73.8	56.9	67.0	44.1	30.6	67.4	77.2	62.7	75.0
Nitrate (NO_3^-) ($mg\ l^{-1}$)	-1.1	3.4	22.8	25.6	51.2	81	61.6	80.4	26.1	28.4	54.6	86.8	51.2	83.2
Iron ($mg\ l^{-1}$)	1.6	9.9	8.6	7.6	41	50.8	41.8	38	10.3	9.7	54.6	55	38.9	42.7
Cupper($mg\ l^{-1}$)	3.9	2.5	9.8	-13.0	29.4	20.7	21.3	16.0	10.5	3.2	20.9	26.8	16.3	25.7
Cadmium ($mg\ l^{-1}$)	12.8	14.2	11.7	25.0	23.5	39.2	17.6	35.7	11.7	26.1	29.4	41.6	14.7	39.2
Lead (mgl^{-1})	7.5	0.6	11.5	7.7	30.9	41.3	51.1	40.9	19.0	11.1	35.4	46.8	32.4	46.8

The *T. angustifolia* has more removal ability compared with *Ph. australis* at the end of experiment (Table 1). The rates of TSS, BOD_5, TDS and Turbidity observed for *T. angustifolia* in {HCW (V&H)} at the end of experiment were 91.41, 96.24, 81.41 and 14.94%. The value of the T.H for *Ph. australis* in design {HCW (V&H)} 19.4 % was more than the value in *T. angustifolia* 18.73%. The value of K, Na and Cl by *T. angustifolia* was 43.1, 28.4 and 24.9% respectively, sodium concentration is important in classifying irrigation water quality because it reacts with soil to reduce its permeability (25). Sodium in irrigation may cause problems Salts that contribute to a salinity problem are water soluble and readily transported by water. A portion of the salts that accumulate from prior irrigations can be moved (leached) below the rooting depth if more irrigation water infiltrates the soil than is used by the crop during the crop season (3) so the significance of sodium hazard in wastewater used for irrigation is since due to the fact that sodium in wastewater is usually about 10% higher than its concentration in fresh water (11). The values of PO_4, NO_3 and NO_2 for *T. angustifolia* in {HCW (V&H)} at the end of the experiment were 72.9, 86.6 and 77.2%. The value of Fe, Cu, Cd and Pb observed for *T .angustifolia* in {HCW (V&H)} at the end of experiment were 55, 26.8, 41.6 and 46.8, Table 1 and Fig 2.

Pollutant removal in wetlands is dependent on plant and microbial mediated reactions, plant and microbial communities take time to establish and reach steady state conditions, development of alternative treatment methods that utilizes the advantages of natural processes in the ecosystem is increasing in the area of wastewater management (5, 16). Various studies have shown that hydroponics has been found to remove nutrients more efficiently and ecologically friendly than constructed wetlands and as a wastewater technology requires less area, is inexpensive and can be implemented onsite (1, 5). It is one of the phytoremediation techniques that attract interest in researches of wastewater treatments. The lower value of EC in the beginning of the experiment at sediment unit was 1.44%, while the highest value was14.94% observed for *T. angustifolia* in {HCW (V&H)} at the end of experiment. Generally, in the results appeared the values of all nutrient in the design {HCW (V&H)} highest while compare with {HCW (H&V)} especially for the end experiment and *T. angustifolia* more ability to accumulate the nutrients compare with *Ph. australis* at the end of experiment, see Fig 1 and 2. The values of TSS, BOD_5, TDS and Turbidity observed for *T. angustifolia* in {HCW (V&H)} at the end of experiment were 91.41, 96.24, 81.41 and 14.94%. The value of the T.H for *Ph. australis* in design {HCW (V&H)} 19.4 % more than *T. angustifolia* 18.73%. The value of K, Na and Cl for *T. angustifolia* 43.1, 28.4 and 24.9%, the result is like (17), found in constructed wetland. The values of PO_4, NO_3 and NO_2 for *T. angustifolia* in {HCW (V&H)} at the end of experiment were 72.9, 86.6 and 77.2%.

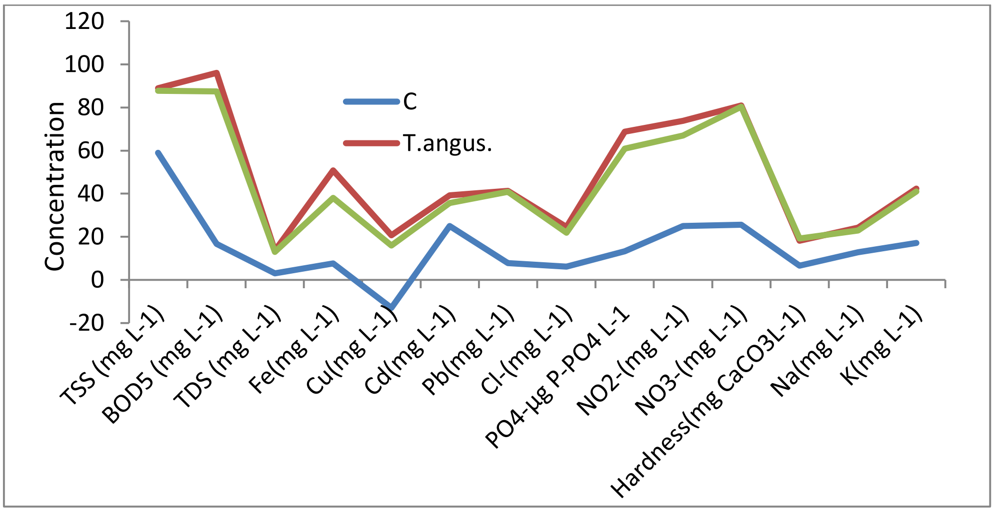


Figure 1. Comparison between control and the effects of the studied Macrophytes at the end stage for H&V hybrid wetland.

Phragmites mauritianus and Vetiver grasses in constructed wetland to treat wastewater, they removed efficiencies of 81.42%TSS, 46.2%COD, 73.6%Cu and 78.2% in Vetiver as compared to 79.3%TSS, 37.9%COD, 64.6%Cu and 50.87% with *Phragmites* (6).

Plants' biomass: The result of the root system for *T. angustifolia* and *Ph. australis* in HCW (H&V) increase the mean values concentrations of (Fe, Cu, Cd and Pb) in *T. angustifolia* to (87.17, 157.1, 125.5 and 99%) respectively, and in *Ph. australis* to **(**108, 55.7, 80.6 and 64.5%) respectively (Table 2). While the root system for *T. angustifolia* and *Ph. australis* in HCW (V&H) increase the mean values concentrations of (Fe, Cu, Cd and Pb) in *T. angustifolia* to (129, 179.3, 130.5 and 167%) respectively, and in *Ph. australis* to (115, 54.4, 120.5 and 81%).

When shoot system for *T. angustifolia* and *Ph. australis* in HCW (H&V) were analyzed, it showed increase in the mean values concentrations of (Fe, Cu, Cd and Pb) in *T. angustifolia* to (85.7, 144.4, 95.1 and 202.4 %) respectively, and in *Ph. australis* to **(**84.6, 60.3, 97.1 and 26.7 %) respectively. While the shoot system for *T. angustifolia* and *Ph. australis* in {HCW (V&H)} showed an increase in the mean values concentrations of (Fe, Cu, Cd and Pb) in *Ph. australis* and *T.angustifolia* to (83.1, 146.9, 100 and110.7%) and to (94.7, 62.2, 139.3 and 84.4 %) respectively. Generally, the results show concentration of all parameters in root and shoot systems for both designs {HCW (H&V and V&H)} except the iron in the root and shoot system in *T. angustifolia* higher than the *Ph. Australis.*

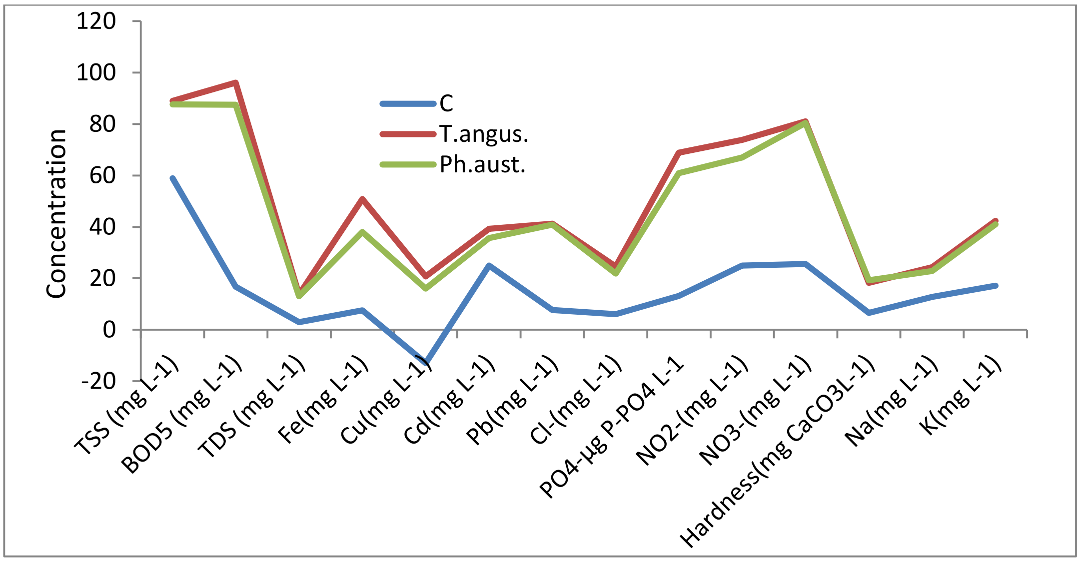


Figure 2. Comparison between control and the effects of the studied Macrophytes at the end stage for V&H hybrid wetland.

Plants having the ability of accumulating heavy metals and other parameters of wastewater have significant influence on our environment (7, 8) and (24). The ion concentration was decreased with the depth which agree with the results obtained by (13) on both Hawler main sewage canal and (17) and Sulaimani sewage canal. This is may be due to removal efficiency of sand which led to an ion blockade because of the filtration process.

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Table 2. Changes in mean values of nutrients content of the root and shoot plants grown in wastewater in Hybrid Constructed Wetland.

Part	Macrophyte	Nutrients	Initial contents in HCW (H&V)	Final contents in HCW (H&V)	% Increase	Initial contents in HCW (V&H)	Final contents in HCW (V&H)	% Increase
Root system	*T. angustifolia*	Iron Fe (µg.g-1)	304	569	87.17	310	710	129
		Cupper Cu (µg.g-1)	21	53.9	157.1	24.7	69	179.3
		Cadmium Cd (µg.g-1)	0.34	0.75	120.5	0.36	0.83	130.5
		Lead Pb(µg.g-1)	21.6	43	99	17.6	47	167
Shoot system	*Ph. Australis*	Iron Fe(µg.g-1)	291	605	108	288	620	115
		Cupper Cu (µg.g-1)	18.3	28.5	55.7	18.9	29.2	54.4
		Cadmium Cd (µg.g-1)	0.31	0.56	80.6	0.34	0.75	120.5
		Lead Pb(µg.g-1)	18.6	30.6	64.5	20.6	37.3	81
Root System	*T. angustifolia*	Iron Fe ($\mu g.g^{-1}$)	252	468	85.7	266	489	83.1
		Cupper Cu ($\mu g.g^{-1}$)	11.7	28.6	144.4	13	32.1	146.9
		Cadmium Cd ($\mu g.g^{-1}$)	0.41	0.8	95.1	0.41	0.82	100
		Lead Pb ($\mu g.g^{-1}$)	16.4	49.6	202.4	19.6	41.3	110.7
Shoot system	*Ph. Australis*	Iron Fe ($\mu g.g^{-1}$)	267	493	84.6	247	481	94.7
		Cupper Cu ($\mu g.g^{-1}$)	11.1	17.8	60.3	12.7	20.6	62.2
		Cadmium Cd ($\mu g.g^{-1}$)	0.35	0.69	97.1	0.33	0.79	139.3
		Lead Pb ($\mu g.g^{-1}$)	21.3	27	26.7	20.6	38	84.4

Generally, this study confirms that the concentration of all nutrients in root and shoot system for both designs {HCW (H&V and V&H)} except the iron in the {HCW (H&V and V&H)} are higher in *T. angustifolia* than the *Ph. Australis*, risodegradation – destruction of organic polluting substances through microbiological activities carried out in the plant root zone (20).Therefore, planting these two macrophytes especially *T. angustifolia* at the wastewater sites can eliminate heavy metals and other waste water parameters by absorbing them into the root and shoot, which in turn reduce the health risk of the wastewater used for irrigation.

Conclusions :The ability of root systems for *T. angustifolia* for accumulation of heavy metals in HCW (H&V) is greater as compared to *Ph. Australis* (except for iron). Results show that concentrations of all parameters in root and shoot systems for both designs (HCW (H&V) and (V&H)) expect for iron in *T. angustifolia* is higher than that in *Ph. Australis*. The ion concentration was decreased with the depth of container.

Values of TSS, BOD_5, TDS and Turbidity observed for potted plants with *T. angustifolia* in (HCW (V&H)) at the end of the experiment were greater as compared to *Ph. Australis*. Results from the present design especially after filtration of waste water through the pots contain *T. angustifolia* macrophytes considered to be suitable for irrigation .The mean value concentration of (Fe^{+2}, Cu^{+2}, and Cd^{+2}) in shoot system of *T. angustifolia* is greater as compared to the shoot system of *Ph. Australis*. The percentage of increasing the concentration of heavy metals in *T. angustifolia* roots is greater for {HCW (V&H)} design. *T. angustifolia* has more removal ability in comparison to *Ph. Australis* at the end of the experiment. 9Results indicated that the removal ability for all parameters with the (HCW (V&H)) system is greater. The result shows an increase in the mean values concentrations of heavy metals and wastewater parameters in root and shoot of both *T. angustifolia* and *Ph. australis* in HCW (H&V) and (V&H). Therefore, Macrophytes in HCW can be used to remove heavy metals and other parameters from waste water used for irrigation.

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