Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.014

ASSESSMENT OF *EICHHORNIA CRASSIPES* (WATER HYACINTH) AS BIO-ACCUMULATOR OF CONTAMINANTS IN DOMESTIC WASTEWATER OF MAKERA AND CHANCHAGA DRAINS

Dadi-mamud Naomi John[1*], Mohammed Aliyu Paiko[2], Aliyu Danjuma Aliyu[1], Anyadike Maria Chiwendu[3] and Joseph Juliana[1].

[1]Department of Biological Sciences, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.
[2]Department of Biochemistry, Ibrahim Badamasi Babangida University, Lapai, Niger State, Nigeria.
[3]Department of Botany and Ecological Studies, University of Uyo, Uyo, Akwa-Ibom State, Nigeria.

*Corresponding Author's Email Address: njdadimamud@gmail.com or aliyudanjumaaliyu@yahoo.com

ABSTRACT
Remediation of the contaminants in domestic wastewater with Bio-accumulators is gaining acceptance in most part of the world. This study analysed the bio-accumulation of the contaminants in the domestic wastewater of Makera and Chanchaga drains in Nigeria by the *Eichhornia crassipes*. The wastewater and the tap water (control) were subjected to treatment with *Eichhornia crassipes*. The Physicochemical parameters of the samples were analysed using portable YSI 556 digital multi sensor Probe, and the plant samples were digested and tested for heavy metals using Atomic Absorption Spectroscopy (AAS). The results obtained indicated that the pH decreased in the Makera (8.47-7.55) and Chanchaga drains (7.73-7.57) while the Control sample shows an increment (6.59-7.56). The conductivity of the samples decreases in Control samples (90-19µS/cm), Chanchaga (110-40µS/cm) and Makera drains (1510-1170µS/cm) respectively. The temperature also decreases in Chanchaga (32-28^{o}C), Makera (31-28^{o}C) and Control sample (28-26^{o}C). The Initial and Final values of the analysed metals were Lead (0.017- 0.007mg/l and 0.017 - 0.000mg/l), Iron (8.600 - 4.714mg/l and 9.000 - 6.143mg/l), Copper (7.600 - 2.350mg/l and 7.350 - 2.100mg/l), Zinc(0.614l-0.281mg/l and 0.614-0.200mg/l),Chromium(0.086 - 0.073mg/l and 0.080 - 0.067mg/l), Mn(0.024 - 2.975mg/l and 0.024 - 0.525mg/l) for Makera and Chanchanga drains. The Control sample has Zn(0.329 and 0.025mg/l), Pb(0.006 and 0.000mg/l), Cu(0.350 and 0.100mg/l), Fe(3.286 and 0.186mg/l), Cr(0.000 and 0.000mg/l), Mn(0.024 and 0.70mg/l). The roots exhibited the highest bio-accumulation of the heavy metals. Thus, *Eichhornia crassipes* through rhizol-filtration can be used as bio-accumulator of toxic heavy metals from wastewater sources.

Keywords: Bioaccumulation, Wastewater, Rhizol-filtration, Heavy metals, *Eichhornia crassipes*

INTRODUCTION
The contamination of the environmental resources with toxic heavy metals has remain a global concern because of their ability to cause bio-magnifications across the food chain (Alkharki *et al.,* 2009a). Heavy metals concentrations in past few years have reached an alarming toxic level which is majorly caused by the anthropogenic activities and urbanization. Nowadays, cities suffer from considerable pollution due to a wide array of substances that contaminate the air, water and soil. Some of these heavy metals are present as by-product of domestic and industrial wastes that mostly end up in the drains and other water sources (Jackson *et al.,* 2012). While their presences in lower concentrations are of metabolic importance, their consistent accumulation over a period of time can be detrimental to the well-being of man. Heavy metals such as Cd, Cu and Fe can be carcinogenic and mutagenic to humans and wildlife (Devi *et al.,* 2011; Hogan, 2012). Domestic wastewater has been reported to contain many toxic metals (Mburu *et al.,* 2013). Remediating the wastewater through the mechanical approach has been the bane of most of the developing countries of the world due to their high running and maintenance cost; while an ecological approach of using plants to remediate contaminated wastewater have an advantage of being a cost-effective and environmental friendly method (Ali *et al.,* 2013).

Water hyacinth (*Eichhornia crassipes*) has a reputation of being one of the world's worst invasive aquatic plant due to its extremely rapid proliferation and congested growth which poses serious challenges in navigation, irrigation, and power generation (Mahamadi *et al.,* 2011). However, it has demonstrated an amazing ability to absorb and concentrate many toxic metals from aquatic environment (Mahamadi *et al.,* 2011). The bioaccumulation of heavy metals by water hyacinth indicates its phytoremediation capacity. Wang *et al*. (2012) conducted a pot experiment to test five wetland plant species; Sharp dock, Duckweed, Water hyacinth, Water dropwort and Calamus for their possible use in remedying the polluted waters. The results show that sharp dock was a good accumulator of N and P while Water hyacinth and duckweed strongly accumulated Cd with a concentration of 462 and 14200 mg/kg respectively. Water hyacinths can be cultivated for waste water treatment especially diary waste water and it can remove efficiently about 60-80% potassium from water (Zhou *et al*., 2007). The rate of absorption of the heavy metal by *Eichhornia crassipes* was reported to depend on the concentration of the metals in the environment (Isreal *et al*., 2017). Fonkou *et al*. (2002) also indicated that the physicochemical parameters of waste water samples containing water hyacinth reduce progressively from the influent to effluent ponds. Thus, the objective of this research is to carry out the assessment of *Eichhornia crassipes* (Water Hyacinth) as Bio-accumulator of contaminants in domestic wastewater of Makera and Chanchaga drains.

Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.014

MATERIALS AND METHOD

Description of the Sampling sites

Makera drain is located in Kaduna State of Nigeria. It has an elevation of 608m above the sea level and coordinates of 10^0 28 '60' N and 7^0 25 '0' E respectively. The Chanchaga drain is located in Minna. It has at an elevation of 111m above the sea level. Its coordinates are $9^0$12ˈ0ˈ N and 6^0 13'0ˈ E. The two drains were being fed continously with the effluents from the residential areas as well as the mining activities located within their vicinities.

SAMPLES COLLECTION AND EXPERIMENTAL PROCEDURES

Water Samples Collection

The three different domestic wastewater samples were collected aseptically from the Makera and Chanchaga drains in Kaduna and Minna respectively. While a clean tap water used as control was collected from one of the laboratory taps in IBB University Lapai. The wastewater samples were properly labelled and transported to the laboratory in an iced condition. The samples were stored in the refrigerator at about 4^0C and analysed for heavy metals analysis before the treatment with *Eichhornia crassipes* to identify the residue metals present in the wastewater.

Plant Sample Collection

Eichhornia crassipes plants were collected from the Agaie River in Agaie town of Niger State. The samples were rinsed with distilled water to avoid any algae growth or microbial activities, and were then taken to the laboratory in plastic bags. They were transfer into tanks for acclimatization until further analysis. All the experimental analyses of the plant samples were carried out at the laboratories in the Centre for Applied Sciences and Technology Research (CASTER), IBB University Lapai, Niger State, Nigeria.

Measurement of Plant Samples Weight

The samples were weighed using Analytical weighing balance. Initial and final weight of the whole plant in the different wastewater samples was taken in order to calculate the relative growth rate (RGR) after the final treatment.

Physicochemical Analysis

The water samples initial values (before the treatment) of pH, Conductivity and Temperature were analysed and recorded daily. The waste water samples were also measured in the laboratory in small quantity and stored in the refrigerator at about 4^oC and analysed for heavy metals before treatment with water hyacinth.

Experimental Setup for the Heavy Metal Uptake

The plants were earlier subjected to acclimatization in tanks for 10 days containing clean water. Final wetlands were constructed using plastic tubs of 100 x 45 x 45 (cm) dimensions. The domestic wastewaters from the sampling sites were introduced into the wetlands. Approximately 250g (Fresh Weight) of the second generations of the plants were collected and planted in the constructed wetlands and used for the effluent treatment. The entire constructed wetlands (CWs) containing Macrophytes were placed in the natural environment. Ten litres of the waste water were added to each constructed wetlands (CWs) for treatment and a control using fresh water was also maintained. After 10 days of treatment, final concentrations of heavy metals in the effluent samples were analysed using Atomic Absorption Spectroscopy (Savant AA – AAS; GBC, Germany). The efficiency of each plant in accumulating heavy metals in their leaf, stem and root were calculated using Bio-concentration factor.

Acid Digestion of Samples and Heavy Metals Analysis

Eichhornia crassipes plant and water samples were digested using hot plate method as described by Yap *et al.* (2009) with modification. One gram (1g) of the pulverized sample was weighed accurately into 250ml conical flask. 15cm^3 of HNO_3 was added into the flask followed by addition of 5cm^3 conc. H_2SO_4. The mixture was shaken to mix and heated on hot plate at 160^oC until all the brown fumes were expelled and white fumes appears. 10cm^{3}of H_2SO_4 was carefully added and heated to dryness. The digest was allowed to cool and 20cm^3 of de-ionize water was added to dissolve the residue. This was filtered quantitatively into 100ml volumetric flask and the residue was washed with de-ionize water into the filtrate and made up to the 100ml mark of the volumetric flask, then the solution sample was transferred into a plastic bottle before taken for metal analysis (aspirated into the machine for trace metal analysis). Standard analysis protocols were observed during the analysis. The metal analysis of Pb, Cu, Zn, Fe, and Cd, Cr, Mn, Mg, K and Na contained in the samples were analysed using Atomic Absorption Spectroscopy (AAS) Bulk Scientific, ACCUSS11. The samples were inserted into the light path where it was illuminated by a hallow cathode lamp (HCL) which emitted light at the wavelength characteristic of the chosen elements. A built-in detector measured the light emissions both in the presence and absence of the samples and the ratio absorbance was used to determine the analytes concentration. The metal concentration bio-accumulated in the plant samples were calculated using the equation below:

Concentration (mg/kg) of metal in the plant samples = (A x B)/C.

Where; A= Concentration of AAS/FIMS analysis (mg/l), B= Volume of sample (L), C= Sample weight (kg).

Bio-concentration Factor

The bio-concentration factor (BCF) was measured to determine the ability of heavy metals accumulation in *Eichhornia crassipes.* It was calculated by dividing the trace element concentration in plant tissues (ppm) at harvest by initial concentration of the element in the external nutrient solution in mg/l

$$\textbf{BCF} = \frac{\text{Concentration of the element in plants tissues at harvest (ppm)}}{\text{Initial concentration of the elements in the external solution mg/l}}$$

Relative Growth Rate

The relative growth rate (RGR) measured the dry matter or amount of biomass production over time, thus RGR was calculated as

$$RGR = \frac{\ln (W_2-W_1)}{T_2-T_1}$$

Where; RGR = Measured as mass increase per aboveground biomass per day (g/ g day), W_1 = Initial dry weight of plant at (g), W_2 = Indicate final dry weight of plant (g), T_1 and T_2 = Initial and final times for treatment respectively (day).

Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.014

Data Analysis
Data generated were subjected to basic descriptive analysis, using Microsoft Excel and presented as mean ± standard deviation. Graphical illustrations of the data were also presented as bar.

RESULTS

Weight of plants before and after the Experimental Setup
The weight of the plants before and after the experiment was indicated in Table 1. The initial and the final recorded weight for the control water with plant samples were 16.11g and 22.85g respectively. That of the samples from Makera drain with the plant is 26.94g and 76.95g while those from the Chanchaga drain was 29.54g and 42.25g respectively

Table 1: Weight of Plants Before and After the Experimental Setup

Plant Samples	Initial Weight	Final Weight
Control water + Water Hyacinth	16.11g	22.85g
Makera drain+ Water Hyacinth	26.94g	76.95g
Chanchaga drain + Water Hyacinth	29.54g	42.25g

Physicochemical Analysis

Conductivity: The initial and final conductivity of each samples were carried out and the result in Fig. 1 showed that the conductivity in control samples reduced drastically as compared to the samples in Makera and Chanchaga drains after the 10days of treatment with water hyacinth.

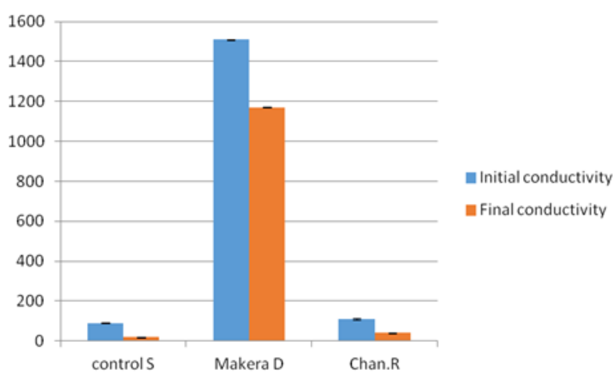

Fig 1: Conductivity of the three Different Water samples

pH: Figure 2 showed the initial and final pH level of different wastewater samples. The result shows that there was reduction of pH in all the water samples while the samples from Makera present the highest pH those of control has the lowest pH values.

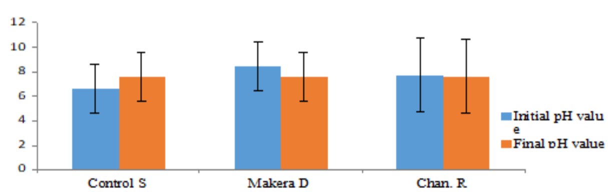

Fig. 2: pH concentration in the three Different Water samples

Temperature: The result in Fig. 3 showed the temperature of the wastewater samples treated with the Macrophytes. The samples taken from the Chanchaga drain recorded the highest final temperature while those from the control samples recorded the lowest initial temperature.

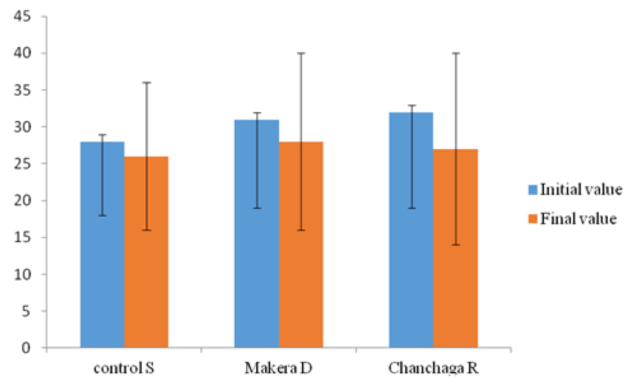

Fig. 3: Temperature value of the Three Different Water samples (^{0}C)

Bio-accumulation of heavy metals in different parts of the plant and in the water sample
The heavy metals concentration in the plant parts was depicted in Fig. 4, 5 and 6 for Control, Chanchaga and Makera wastewater samples. The figures also illustrated different concentration in the plant parts. While most of the analysed heavy metals were detected in different concentration in the parts of the plants, Lead (Pb), Chromium(Cr) and Cadmium (Cd) were absent or detected in minutest form in some samples. In the treatment samples, the concentrations in the plant part increases in an increasing linear order of Root > Stem > Leaves. After the experimental period, the concentrations of the heavy metal generally decrease in all the water samples but gradually increase in the plant tissues.

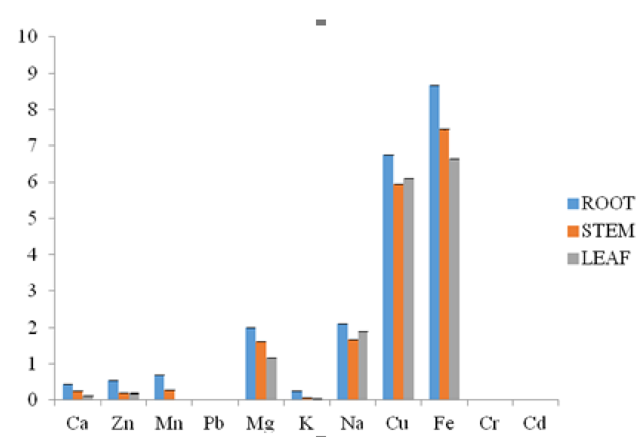

Fig. 4: Bio-accumulation rate of Heavy Metals in Different Parts of the *Eichhornia crassipes* Plant (Root, Stem and Leaves) grown in Control Water samples.

Science World Journal Vol. 15(No 3) 2020
www.scienceworldjournal.org
ISSN 1597-6343
Published by Faculty of Science, Kaduna State University
https://doi.org/10.47514/swj/15.03.2020.014

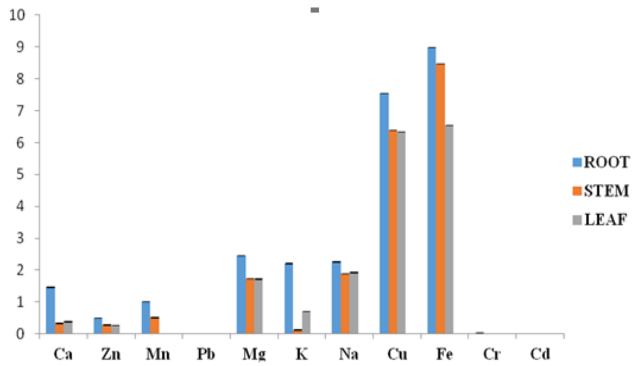

Fig. 5: Bio-accumulation rate of Heavy Metals in Different Parts of the *Eichhornia crassipes* Plant (Root, Stem and Leaves) grown in Wastewater samples from the Chanchaga Drain

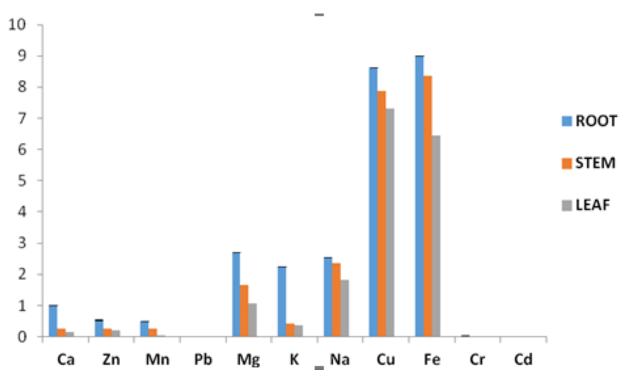

Fig. 6: Bio-accumulation Rate of Heavy Metals in Different Parts of the *Eichhornia crassipes* Plant (Root, Stem and Leaves) grown in Wastewater samples from the Makera Drain

Bio-concentration factor

The Bio-concentration factors in each station were presented in Fig.7. The plant exhibits differences in bio-concentration values of different heavy metals analysed in different water samples. There was high bio-concentration factor of the analysed metal in the plant in Control water sample than in the plant in the treatment water samples, while Copper (Cu) was recorded to have the highest bio-concentration factor in the control samples treated with the Macrophytes, Manganese (Mn) was recorded the lowest. The heavy metals with the highest and lowest bio-concentration in samples treated with Macrophytes from the Makera drain were Sodium (Na) and Manganese (Mn) respectively. Two heavy metals of Sodium (Na) and Copper (Cu) have the same bio-concentration factors in the samples treated with Macrophytes and collected from the Chanchaga drain while the lowest was Zinc (Zn).

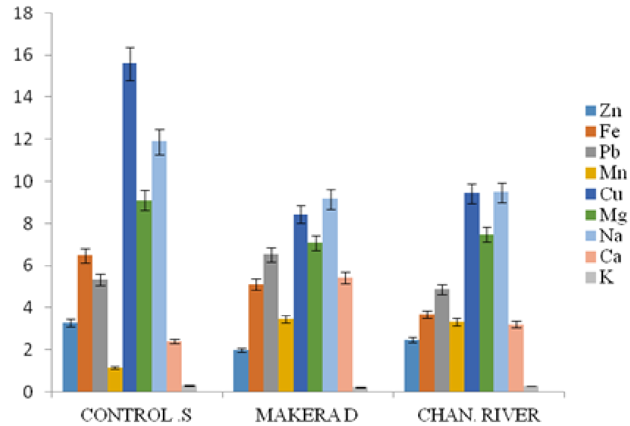

Fig. 7: Bio-concentration factor of Heavy Metals in Different Parts of the *Eichhornia crassipes* Plant (Root, Stem and Leaves) grown in water samples from Control, Chanchaga and Makera Drains

Relative Growth Rate (RGR)

The effect of metals (Zn, Fe, Pb, Mn, Cu, Mg, Na, Ca, K) on the relative growth rate (RGR) of water hyacinth (*Eichhornia crassipes*) at different samples were shown in figure 8. An increase in plant growth was observed which was more profound in Makera Drain wastewater than in other wastewater samples.

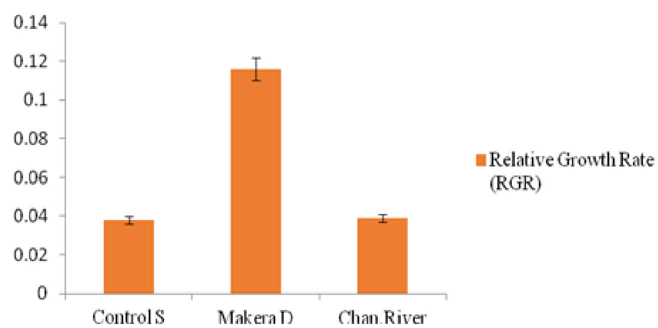

Fig 8: The Effect of Metals on Relative Growth Rate (RGR) of Water Hyacinth at the three Different Sampling station

DISCUSSION

Eichhornia crassipes although an invasive macrophytes with an extremely rapid proliferation that present serious obstacles in navigation, irrigation, and power generation (Mahamadi *et al.*, 2011), has however been utilised in different climes for the phytoremediation activities of many toxic metals from the aquatic environment (Sarwat, 2012; Sotolu, 2013). This research support the assertion above, since it was observed that *Eichhornia crassipes* utilised in this study accumulate high heavy metals in varying concentration in different part of the plant. This could be attributed to its extensive fibrous roots system which provide an enormous surface area that absorbs and accumulate water and mineral nutrient from the substrate for it metabolic activities; which aids it growth and development. As part of the metabolic process too, the plant may extract the metals for the transport to the above the ground part for their use. These findings contrasted with the observations reported by Lu *et al.* (2014), where they reported a higher concentration of their studied heavy metals in the aerial parts of stems and leaves as compared to the roots that had a low heavy metals accumulation rate. This finding could be due to some physical barriers that causes an impediments in the root system. The rate of the absorption of the analysed heavy metal by the water hyacinth plant depends on the concentration of such metals present in the water sampled as observed during the experiment and this was supported by the research conducted by Isreal *et al*. (2017). The root was therefore considered crucial for the absorption of element in free floating plants. The metal concentration within the plant tissues showed linear increase; Root > Stem > Leave, with gradual decrease in its concentration as earlier observed at the initial stage of the experiment, this could be probably the effect of the translocation and transportation pattern of nutrient materials and water within the water hyacinth (Maine *et al*., 2007).

The Bio-concentration values of water hyacinth in some previous study in the different water samples identify it to be among the hyper-accumulator plants, whereby it survives in the presence of an elevated concentration of heavy metals when it is not expected to. These phenomenon have been earlier reported by Nyawira *et al*. (2016) and Mokhter *et al*. (2011) in their works where the bio-concentration value of water hyacinth for Cu in an aqueous solution containing various concentration of copper (1.5, 2.5 and 5.5mg/L of copper) for a period of 21days, the root and shoot tissues showed an increase in concentration with decrease in aqueous solution. Although these findings of hyperaccumulation by water hyacinth reported above by Nyawira *et al*. (2016) and Mokhter *et al*. (2011) contrasted the findings of this research, it however shows it suitability for bio-accumulation in significant concentrations.

Growth changes are often the first and most obvious reaction of plant under heavy metal stress (Elenwo, 2016). There was relative increase in the plant growth throughout the experimental period in all the different water samples with a maximum increase observed in the Makera drains wastewater sample. This could be due to the utilization of the mineral nutrient present in the waste water samples, low concentration of these metal in Makera drain since they are essential for plant growth but in a very low concentration, and also the time duration of the experiment. The absence of Cadmium (Cd) also assisted in the survival of the plant in the treatment cultures because Cd causes toxicity and reduction in growth of the plant if presence in abundance. The Physiochemical analysis of different water samples showed an increase in the pH values of the Control sample (6.59-7.56) and decrease in the Makera drain (8.47-7.55) and Chanchaga drain (7.73-7.57), this could be due to the presence of impurities which reduces the pH. The conductivity of the different samples showed gradual decrease towards the end of the experiment. This is an indication that certain parts of the plants were responsible for the observed decrease in the concentration of heavy metals in water.

Conclusion

The role of *Eichhornia crassipes* in treating contaminants in the domestic wastewater of Makera and Chanchaga drains was studied. The accumulation of various heavy metals in the plant parts in varying concentrations showed the potential of the plant as a good bio-accumulator of contaminants. The higher concentration of the heavy metals in the roots as compared to the stem and leaves of *Eichhornia crassipes* is an indication of rhizofilteration as the primary source of remediation while it also has the ability to carry out significant phytoextraction and phytostabilization. Therefore, it can be deployed as a phytoremediating agent in many parts of the developing countries with high volume of contaminants in domestic wastewater but low treatment priorities. This method will serve as a long lasting cost-effective and solution. It will also add aesthetic value to the environment and preserve the nature.

Acknowledgement

We are grateful to TETfund and IBB University Lapai, Nigeria for the support and assistance towards the financing and provision of some facilities for the research

REFERENCES

Ali, H., Khan, E., and Sajad, M.A. (2013). Phytoremediation of heavy metals-concepts and applications. *Chemosphere,* 91(7):869-881.

Alkarkhi, A. F., Ahmad, A., and Easa, A. M. (2009a). Assessment of surface water quality of selected estuaries of Malaysia: Multivariate statistical techniques. *The Environmentalist*, 29(3):255-262.

Devi, M. P., Reddy, M. V., Juwarkar, A., Sarma, P. N., and Mohan, S. R. V. (2011). Effect of Co-culture and Nutrients Supplementation on Bioremediation of Crude Petroleum Sludge. *Clean–Soil, Air, Water*: 39(10):900-907.

Elenwo E.I. (2016*)*. *[The Estimation of Potential Yield of Water Hyacinth: A review. Infinity Press]*.

Fonkou, T., Agendia, P., Kengne, I., Akoa, A. and Nya, J. (2002). Potentials of water lettuce (*Pistia stratiotes*) in domestic sewage treatment with macrophytic lagoon systems in Cameroon. *In: Process of International Symposium on Environmental Pollution Control and Waste Management, Tunis*, 709-714.

Hogan, C. M. (2012). Heavy metal. In: *Encyclopaedia of Earth*. Eds. Cutler J. Cleveland (Washington, D.C.: Environmental Information Coalition, National Council for Science and the Environment).

Isreal, U., Ugochukwu, O., Ndimele, C. C. and Ndimele, P. E. (2017). Phytoremediation of Heavy Metal; Polluted Aquatic Ecosystem Ologe Lagoon by *Eichhornia crassipes* (Mart). *Doc. 5th International Conference on Green Chemistry and Technology.*

Jackson, B. P., Taylor, V.F., Punshon, T., and Cottingham, K. L. (2012). Arsenic concentration and speciation in Infant formulas and first foods. *Pure Applied Chem*istry, 84(2):215-223.

Lu, Q., He, Z. L., Graetz, D. A., Stoffella, P.J. and Yang, X. (2014). Phytoremediation to Remove Nutrients and Improve Eutrophic Stormwaters using water lettuce (*Pistia stratiotes* L). *Environmental Science Pollution Resource*, 17, 84-96.

Mahamadi, C. (2011). Water hyacinth as a Biosorbent: A review. *African Journal of Environmental Science and Technology*, *5*(13)1138 - 1139.

Maine, M.A., Suné, N., Hadad, H., Sanchez, G. And Bonetto, C. (2007a). Removal efficiency of a constructed wetland for wastewater treatment according to vegetation dominance. *Chemosphere,* 68:1105-1113.

Mburu, N., Tebitendwa, S. M., Rousseau, D. P., Van Bruggen, J. J. A., and Lens, P. N. (2012). Performance evaluation of horizontal subsurface flow–constructed wetlands for the treatment of domestic wastewater in the tropics. *Journal of Environmental Engineering*, 139(3):358-367.

Mokhtar, H., Morad N. and Fizri F. F. (2011). Phytoremediation of Copper from Aqueous Solution using *Eichhornia Crassipes* and C*entella asiatica. International Journal of Environment Science Development.*

Nyawira, O., Matindi, P. and Christine, S. **(**2016**)**. *Analysis of Heavy Metal Content in Water Hyacinth (Eichhornia Crassipes) From Lake Victoria And Assessment of Its Potential As A Feedstock For Biogas Production.* A thesis submitted in partial fulfillment for the award of the Degree of Master of Science in Nuclear Science in the University of Nairobi 2016.

Sarwat, I. (2012). Phytoremediation: A Green Technology. *Iranian Journal of Plant Physiology,* 3(1), 567 - 576.

Sotolu A. O. (2013). Management and Utilization of Weed: Water Hyacinth (*Eichhornia crassipes*) for Improved Aquatic Resources. *Journal of Fisheries and Aquatic Science,* 8.

Wang, W., Gao, J., Guo, X., Li, W., Tian, X., and Zhang, R. (2012). Long-term effects and performance of two-stage baffled surface flow constructed wetland treating polluted river. *Ecological Engineering*, 49:93-103.

Yap, D.W., Adezrian, J., Khairiah, J., Ismail, B.S., and Ahmad-Mahir, R. (2009).The uptake of heavy metals by paddy plants (*Oryza sativa*) in Kota Marudu, Sabah, Malaysia*. American-Eurasian Journal of Agricultural and Environmental Science*, 6(1):16-19.

Zhou, W., Zhu, D.T., Liao, S., Hu, H. and David, H. (2007). Extraction and Retrieval of Potassium from *Eichhornia crassipes*. *Bioresearch Technology,* 5:234-242.