

Water Pollution Management Using *Eichhornia Crassipes* (Water Hyacinth)

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Abstract

In this study, *Eichhornia crassipes* (water hyacinth) was used to remove excess nutrients from polluted water. 5 litres of wastewater was collected in plastic containers in 3 stations from the river at the mixing points of sewage and other waste materials in the downstream, midstream and upstream positions. These were analyzed in the laboratory to determine the most polluted area of the river (table 1). About 20 litres of water was collected from Atabong river in Eket, adjudged to be rich in nutrients due to the discharge of animal dung, tissues, blood, waste foods, decayed vegetation, rotten bones, pesticides and sewage material from the proliferation of Abattoirs around the river banks. The water collected was emptied into a 20L rubber basin and water hyacinth was planted in it at the demonstration site as shown (fig 2). Young Water hyacinth was collected from a drainage at Uyo and taken to Akwa Ibom State University, Ikot Akpaden where they were planted in a container containing 15 litres of polluted water taken from Atabong River. Water from the downstream was used for the planting because it was observed that it was to be the most pollute (table 1). The results revealed that water hyacinth, (*Eichhornia crassipes*) plants absorbed excess nutrients such as nitrate, phosphate, silicate and also heavy metals (iron, nickel and vanadium) from the polluted in water twenty-one days after they were planted (figs.4-7). If Water hyacinth is planted at the riverbanks where activities that could pollute the water bodies are carried out, it could absorb these pollutants especially the excess nutrients that are capable of causing dead zones as a result of eutrophication in the freshwater bodies.

Keywords: Water Pollution, Water Hyacinth, Wastewater Treatment, Remediation.

I. INTRODUCTION

Water is a very essential need of man. With the industrial revolution, technology and increase in urbanization, finding clean water now is very difficult. Most industries are located either at the banks of rivers or at the coastal zone of the seas or oceans where most of them discharge raw and untreated sewage into these water bodies. In urban area also, untreated sewage are discharged directly into water bodies. Such sewage carries with them nutrients heavy metals and pathogens. As a result, finding clean and unpolluted water is a very big challenge now. Water pollution has now become a very big challenge especially in developing countries. In Southern Nigeria for instance there is water everywhere but finding clean portable water is a big challenge pollution from the oilfields. We can hardly drink water from our streams or rivers due to pollution from oil spills, domestic sewage, agricultural practices, industrial waste water discharges as

well as solid wastes. United Nations Sustainable Development Goals (SDG 6) recognizes the need for clean water.

According to Nathanson (2026), water pollution, is the discharge of pollutants into subterranean groundwater or into bodies of water such as lakes, streams, rivers, estuaries, and seas in a way that impairs their usefulness for human use or the ecological processes at work.

Eichhornia crassipes (Water Hyacinth), a unique aquatic vascular plant with the ability to reduce organic pollutants, absorb nutrients, and adsorb heavy metals. It is well-known for its impact on the environment and society.

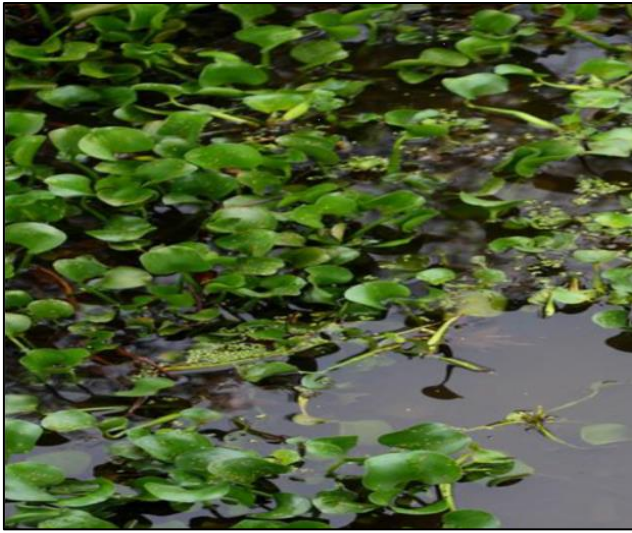


Fig 1 Water Hyacinth Floating in Water (Ratchanon Keawmanee, 2015)

Eichhornia crassipes is from the family Pontederiaceae. (Parsons and Cuthbertson 2001). Among aquatic plants, only *E. crassipes* is considered a pan-tropical weed (Coetzee et al., 2009). The Weed Science Society of America decided to call this plant water-hyacinth because it is not related to the real "hyacinth" (*Hyacinthus* spp.), which are aquatic plants (Center et al., 2002). German botanist C. V. Martius found water hyacinth in 1823 while researching Brazilian flora; he dubbed it *Pontederia crassipes*; and sixty years later, Solms placed it in the genus *Eichhornia*. Water hyacinths originally hail from Brazil. In many warm areas of the world, including Central and North America, Asia, Africa, Australia, and New Zealand, water hyacinths are valued by humans for their lovely blossoms (Dersseh et al. 2019). Due to lack of natural adversaries, the introduction and spread of water hyacinth have been especially impactful in Africa. The weed was initially documented in Zimbabwe in 1937, according to a survey of water hyacinth infestation in eastern, southern, and central Africa. From 1989 to 1990, the plant was documented in Victoria. Roughly 30 million people call Africa's second-largest freshwater lake, Lake Victoria, home. The water hyacinth infestation in the lake has caused a lot of trouble and anger among the people. The weed's projected daily growth rate on the lake reached 3 hectares (12 acres) during its peak period. Additionally, the plant rapidly expanded across the waterways of Uganda in a span of only a decade. West Africa is now home to water hyacinth as well. Wetlands in Cameroon have been designated as "home" for the weed since its initial reports occurred between 1997 and 2000. For a long time, water hyacinth has been the dominant plant in Nigerian rivers. Amy (2009) noted that water hyacinth frequently blocks waterways because of how quickly it reproduces and spreads.

Water hyacinth, on the other hand, has a lot of phytoremediation potential, including nutrient intake, heavy metal absorption, and organic pollution reduction (Monroy-Licht et al. 2022, Matlhatse et al, 2025). Despite its widespread presence, this plant is largely underutilized as a low-cost, eco-friendly tool for water pollution management.



Fig 2 Water Hyacinth in a Controlled Environment for Wastewater Treatment Experiment and Removal of Excess Nutrient (Ratchanon Keawmanee, 2015).

The seventeen Sustainable Development Goals (SDGs) included in the 2015-established 2030 Agenda seek to solve global concerns. Goal No. 6, "Clean Water," is responsible for improving water quality, managing wastewater discharges, and expanding access to basic sanitation. As many as eleven of the seventeen Sustainable Development Goals (SDGs) may be aided by wastewater treatment. To that end, phytoremediation offers a flexible and inexpensive substitute for conventional methods of controlling and reducing aquatic contaminants (Monroy-Licht, et al. 2024).

Eichhornia crassipes offers potential for eco-friendly applications such as producing bioenergy, cleaning up polluted areas, making organic fertilizer, and feeding animals. A possible strategy to turn a dangerous invader into a useful resource is to make use of these advantages, which is in line with circular economic concepts. (Matlhatse et al, 2025, Ekong & Ekanim, 2023)

E. crassipes exhibits the exceptional capacity to absorb and remove a wide range of harmful compounds from the environment, offering a promising approach to combating pollution. It is very suitable for use in phytoremediation in the treatment of industrial and domestic wastewater due to its tolerance to different pH and temperature conditions. (Monroy-Licht et al. 2022)

There is therefore a need to scientifically evaluate the effectiveness of *Eichhornia crassipes* in improving water quality parameters and to assess its potential application as a sustainable water pollution management strategy, particularly in resource-limited settings.

The main objective of this study was to examine the ability of water hyacinth to remove this excess nutrients (Nitrate (NO₃), phosphate (PO₄), and silicate) as well as heavy metals like Cadmium, vanadium, iron, lead, mercury and nickel from polluted water; which, when successfully carried out, could be used to remediated water

bodies polluted by excess nutrients and heavy metals. It could also be used by industries for waste water treatment before discharging into water bodies at no cost. And can be used to remediate eutrophicated ecosystem as well as dead zones.

The dense mats assist water hyacinth in the absorption of nutrients, organic pollutants, and heavy metals (Tiwari et al., 2007; Zimmels et al., 2007). There was a correlation between the concentration of mercury in water hyacinth leaf tissue and that in the underlying sediment in California, indicating that, with proper disposal, water hyacinth plant harvesting could mediate mercury (Greenfield et al., 2007). Additionally, water hyacinth could be a viable biological option for wastewater treatment processes that involve secondary and tertiary processes due to its ability to absorb nutrients (Cossu *et al.*, 2001).

Heavy metals are carcinogenic even at trace amounts. The quantities of these elements in aquatic environments have grown due to human activities such as mining, industrial operations, and geochemical investigations, even though they are naturally occurring components of the Earth's crust. Many industrial processes, including those involved in making insecticides, batteries, and mining, make use of heavy metals.

Living organisms cannot function properly without small levels of heavy metals like iron, copper, and zinc; nevertheless, these metals bioaccumulate and aren't biodegradable, thus exposure to higher concentrations poses health risks (Crini, 2005). Because of this, they remain in the environment for a long time. For example, cadmium and mercury are toxic at extremely low amounts.

Heavy metals are hazardous to human and environmental health because they are not metabolized by the body; as a result, they build up in soft tissues. Some of the ways that heavy metals can end up in people's bodies are through the food chain, water, air, and skin absorption. There are both short-term and long-term negative impacts of lead exposure on human health, particularly in adults (Ekanim, et. al. 2016). It is harmful to multiple organ systems and can affect the nervous, cardiovascular, kidney, gastrointestinal, blood, and reproductive systems (Volesky, 2007).

Water hyacinth's ability to absorb these pollutants has also been confirmed by a number of field investigations. According to Rodríguez-Gallego et al. (2004), Monroy-Licht et al. (2022), and Matlhatse et al. (2025), this macrophyte has a higher rate of nutrient absorption than other macrophytes. As a result, depending on the density and area of cover, it might potentially decrease nutrient concentrations in water bodies (Monroy-Licht *et al.* 2022).

The ability of water hyacinth to absorb nitrate (NO₃), ammonium (NH₄), and phosphate (PO₄) from the water column was examined in a laboratory experiment that Rommens et al. (2003) set up to simulate the nutritional

conditions of Lake Chivero, Uganda. Rommens et al. (2003), each hour, one kilogram of water hyacinth (wet weight) absorbed 2.36 milligrams of ammonium, 1.13 milligrams of nitrate, and 0.39 milligrams of phosphate. From a managerial standpoint, these findings could be utilized to assess the possible nutrient response in systems affected by the introduction or removal of water hyacinth.

Nutrient reductions would be dependent on the density of water hyacinth cover, while water hyacinth has the ability to offer phytoremediation in extremely eutrophic settings. So, other effects of water hyacinth would also determine the overall advantages of a phytoremediation strategy. The nitrogen and phosphorus levels in the water column were found to be considerably higher after water hyacinth was shredded, according to Greenfield et al. (2007). Water hyacinth had previously covered 30% of Lake Chivero before it was biologically managed in the 1990s; Marshall (1997) found that nitrogen and phosphorus levels rose after the control. Water hyacinth grows well and proliferate where there is high level of nutrients and suitable temperature (Wilson *et al.* 2007).

However, salinity tend to restrict its spread to estuaries and coastal regions. Excess of nutrients in sewage may pose an issue for nearby bodies of water that have been used as sewage dumps. Since some heavy metals are potentially poisonous even at extremely low concentrations, heavy metal pollution poses a significant risk to aquatic ecosystems. In addition to being extremely harmful to humans and animals alike, heavy metals are not biodegradable and have a tendency to bio-accumulate in the tissues of living things (Crini, 2005).

Heavy metals in water have long occupied the minds of scientists concerned about the harm they do to aquatic life, humans, and the environment. They pose a threat to public health in industrial effluents and drinking water because, unlike organic contaminants, they do not biodegrade (Ibrahim et al., 2010). There are a number of popular methods and technologies used to remove metal ions from wastewater, which is crucial for reducing the concentration of heavy metals and surplus nutrients in aquatic ecosystems. Materials science, chemistry, and biology make up the bulk of these approaches. Natural removal of these excess nutrients (sewage) through the use of water hyacinth is very necessary; which is the aim of this research.

One of the many water contaminants that is a big problem in poor nations is untreated sewage, which contains nitrates and phosphates. When sewage nutrient levels, including phosphates and nitrates, are too high, it can cause eutrophication. In addition, even trace amounts of heavy metals in water might have harmful effects. The primary goal of this research is to determine how effective water hyacinth is at removing these nutrients.

E. crassipes can be used to remove cadmium, vanadium, iron, lead, mercury and nickel from the waste water as a natural means of water purification in aquatic

environment. The development of auto-immunity, in which the immune system assaults its own cells, can be triggered by exposure to certain metals like lead and mercury. This can cause foetal brain damage, kidney disease, circulatory system disease, neurological system disease, and inflammatory joint diseases including rheumatoid arthritis. Strict environmental standards and the preservation of the ecosystem for future generations both necessitate the treatment of wastewater that is contaminated with these metals and excessive nutrients before release (UNEP, 2008). There are many types of pollutants in water which is a major concern in developing countries; eg nutrients from untreated sewage such as nitrates and phosphates in excess may lead to eutrophication. Also, the presence of heavy metals in water is toxic even at very low concentrations.

The ability of water hyacinth to remove this excess nutrients (Nitrate (NO₃), phosphate (PO₄), and silicate) as well as heavy metals mainly Cadmium, vanadium, iron, lead, mercury and nickel from polluted water is the main objective of this study. If successfully carried out, it will

be used to remediate water bodies polluted by excess nutrients and heavy metals. It could also be used by industries for wastewater treatment before discharging into waster bodies at no cost.

II. MATERIALS AND METHOD

The sampling site was Atabong stream located within longitude 7° 46' 2" E to latitude 4°37'23" N in Eket Local Government Area of Akwa Ibom State, Nigeria. Three sampling stations covering distance of 4km that were selected in the downstream, middle stream and upstream areas. The choice of site was on proximity to the dumping sites for animal waste, refuse, pesticides, human activities like washing, discharge of human waste, cooked food, and the cultivation of leafy vegetables like fluted pumpkin (*Telferia occidentalis*) by farmers. Atabong river is a freshwater river in Eket Local Government Area which is relatively shallow, with a maximum depth of about 10m and a mean depth of 6m. It is a biological hotspot with great biodiversity. The river lies along Eket-Uyo road in Eket LGA Akwa Ibom State, Nigeria.

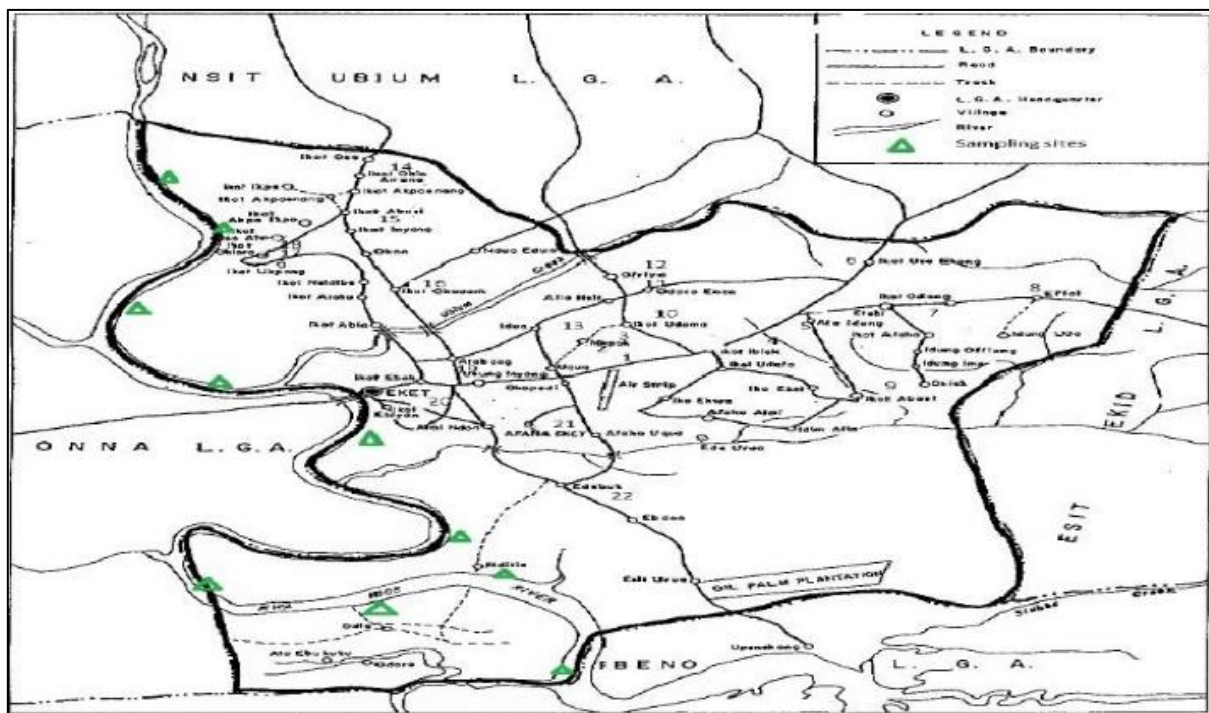


Fig 3 Map of Eket Community Showing the Sampling Stations

➤ Sample Preparation and Analysis

About 15 litres of wastewater was collected in plastic containers from the river at mixing point of sewage and other waste materials. The water was collected from 3 stations; the downstream, midstream and upstream; 15litres each. These were first analyzed in the laboratory to determine the most polluted area of the river (table 1).

Young water hyacinths were collected from a drainage at Uyo and taken to Akwa Ibom State University, Ikot Akpaden where they were planted in a container containing 15 litres of polluted water collected from Atabong River. Water from the downstream, being the most polluted was used for the planting. because it was observed that it was the most polluted. (table 1).



Fig 4 Day One; from Where Water Hyacinth was Planted

On the first day, the plants were planted in the plastic basin (fig.4). The stolons that held the sands to the mother plant's roots were incredibly delicate, so they could easily break. This let the young individuals to create new colonies by floating away.

III. RESULTS AND DISCUSSION

➤ Results

Major parameters such as Phosphate, Silicate, Nitrate, Iron, lead, V, Ni, Hg and Cadmium were analyzed

in line with APHA (1995), Standard method for examination of water and wastewater.

The result of the experiment is as presented in table 2. From the result in table 2, it was observed that water hyacinth absorbed nutrients and heavy metals from wastewater using it to proliferate in large numbers in less than twenty-one days. This study revealed that water hyacinth absorbed more nutrients than heavy metals.

Table 1 Initial Analysis of Some Parameters in the River Water

S/ No.	Parameters (mg/l)	Up Stream (mg/l)	MidStream (mg/l)	Down Stream (mg/l)	Mean	Standard Deviation
1	Phosphate	0.452±0.77	2.601±0.13	4.210 ±1.26	2.421	3.42
2	Nitrate	2.130±3.37	8.023±0.67	11.063±2.82	7.072	10.01
3	Silicate	1.203±2.14	5.462±0.87	6.018±1.26	4.23	5.98
4	Lead	0.253±0.12	0.421±0.02	0.602±0.13	0.425	0.60
5	Iron	1.0614±0.24	1.1321±0.19	2.024±0.44	1.406	1.99
6	Vanadium	0.00	0.00	0.00	0.00	0
7	Mercury	0.00	0.00	0.00	0.00	0
8	Nickel	0.1824±0.01	0.1923±0.004	0.2204±0.02	0.198	0.28
9	Cadmium	0.135±0.83	1.381±0.05	2.417±0.78	1.311	0.80

After 3 days, plants that were mistakenly cutoff from the root during uprooting began to withered and die off. On day7, it was observed that the plants began to reproduce and invaded the water. The plants grew and the stolon broke up to produce young water hyacinth plants. The young individuals absorbed excess nutrient and heavy metals in water and grew rapidly and invaded the container (fig.5).



Fig 5 Growth of Water Hyacinth in Day 7.

On day14, it was observed that the plants became matured and produced flowers. (fig.6).



Fig 6 Growth of Water Hyacinth in Day 14.

As the absorption of nutrients and phytoremediation continues, the nutrients and metals drastically reduced. This was observed in the reduction of growth and yellowing of the leaves. (Fig. 7 and table 2.)



Fig 7 Growth of Water Hyacinth in Day in 21 Indicating Nutrient Depletion.

Table 2 Final Analysis of Water After Planting Water Hyacinth for 21 Days

S/No.	Parameters	Permissible Limit (mg/l)	Water Profile after planting the Water Hyacinth for 21 days (mg/l)
1	Phosphate (PO ₄)	3.50	0.262
2	Nitrate (NO ₃)	0.9	0.135
3	Silicate	NA	0.827
4	Lead (Pb)	0.01	1.013
5	Iron (Fe)	0.3	0.986
6	Vanadium (v)	5.00	0.006
7	Mercury (Hg)	0.001	0.00
8	Nickel (Ni)	0.02	0.067
9	Cadmium (Cd)	0.003	0.568

➤ Discussion

The results of the experiments carried out revealed that water hyacinth, (*Eichhornia crassipes*) plant absorbed excess nutrients such as nitrate, phosphate, silicate and heavy metals iron, nickel and vanadium from polluted water. (Romen *et al* 2003, Rodríguez-Gallego *et al.*, 2004; Monroy-Licht *et al.* 2022). The final analysis revealed a considerable decrease in phosphate, nitrate, silicate, vanadium, nickel, and iron concentrations. (Tiwari *et al.*, 2007;). It was determined that there was minimal loss owing to evaporation and settlement. The mercury concentration was less than the detection limit of 0.001 mg/l. Atmospheric deposition, planting dust, and sand may have contributed to the rising lead value. Based on the findings, water hyacinth is a viable option for treating wastewater by removing nutrients and heavy metals. This could be used to remediate eutrophication (table 2).

Eutrophication is one major problem found in water bodies in tropics and sub-tropics this pollution is as a result of poor agricultural and industrial practices, run-off in some areas, climate change and perturbation linked to leisure, tourism, deforestation of riparian vegetation, sand and gravel extraction which introduce excess nutrients and heavy metals into the aquatic ecosystem.

The aggressive invasion of floating water hyacinth that is always a big problem in tropical countries, including Nigerian coastal states can be turn into a remedy/mitigative factor to excess nutrient and heavy metals under a controlled measure. Therefore, water purification potential of water hyacinth can provide the coastal states and communities with consumable water. (Slak *et al.* 2005).

It can also be used at the near dead zones of the aquatic environment stemming from the discharge of untreated wastewater from both municipal and industrial areas.

E. crassipes the water hyacinth, or floating water plant, is a perennial with dark green, fan-shaped leaflets held aloft by an inflated petiole. Its large, densely branching, black fibrous root system is submerged under water. The water hyacinth can quickly spread over vast amounts of water due to its rapid growth rate. Its optimum temperature for growth is 25- 30°C. Heavy metals entering

the stream originate from different sources such as decaying plants and vegetation, atmospheric particulates, discharge of domestic, agricultural and municipal wastes, etc.

Due to excess sewage and animal waste from abattoir located close to the river discharged into the river, the increase in nutrient content could have a significant impact on the ecosystem by creating an ideal setting for algal blooms and other species to thrive. These contaminants can be absorbed and stored in the biomass of aquatic macrophytes such as water hyacinth. The term "bio-accumulator" describes these plants because of the way they store pollutants in their tissues. They can absorb a lot of nutrients and heavy metals and have a high tolerance for these toxins (Ansari *et al.*, 2020). Phytoextraction is the process of removing nutrients and heavy metals from contaminated water bodies. Even though they take in less pollutants overall, plants with a rapid rate of growth and biomass production can nevertheless extract a lot of pollutants from soil through phytoextraction (Guidi, *et al.*, 2018). There are three ways that pollutants are taken in:

- *Root Absorption-*

As the roots take in water, they also take in any pollutants that may be in it. Heavy metals may be transported to the roots system, where active absorption occurs, by means of a notable cation exchange induced by carboxyl groups at the roots system, which passes through the cell membrane. The root systems of aquatic plants, including water hyacinth, offer an ideal habitat for aerobic bacteria to thrive in sewage systems. Plants rely on aerobic bacteria for their sustenance because these microbes break down nutrients into inorganic chemicals. Rapid plant growth allows for easy harvesting of compost that is both rich and profitable. It was found that water hyacinth could filter out harmful bacteria, heavy metals, chemical substances, and nutrients (fig.7 and table 3).

The standard process that was carried out with known concentrations of phosphate, nitrate, silicate, lead, iron, vanadium, mercury, nickel and cadmium (table 1). Water hyacinth leaves changed to yellow due to insufficient nutrients. (fig. 7 and table 3). When there is excess nutrients; prolific growth becomes a problem for waterways.

Table 3 Comparing the Level of Nutrients and Heavy Metals Water Before and After Planting *Eichhornia crassipes*

S/ No.	Parameter	Permissible Limit (mg/l)	Before planting <i>Eichhornia crassipes</i> (mg/l)	After planting <i>Eichhornia crassipes</i> (mg/l)
1	Phosphate (PO ₄)	3.50	4.210 ±1.26	0.262
2	Nitrate (NO ₃)	10	11.063 ±2.82	0.135
3	Silicate	NA	6.018 ±1.26	0.827
4	Lead (Pb)	0.01	0.602 ±0.13	1.013
5	Iron (Fe)	0.3	2.024 ±0.44	0.986
6	Vanadium (v)	5.00	0.000	0.000
7	Mercury (Hg)	0.001	0.000	0.000
8	Nickel (Ni)	0.02	0.2204 ±0.02	0.067
9	Cadmium (Cd)	0.003	2.417 ±0.78	0.568

➤ *Phosphate Removal*

Phosphate was found to be 4.210 ±1.26 mg/l at the initial level which was higher than the permissible level 3.50mg/l. In 21 days, phosphate was reduced to 0.262mg/l,

the removal of phosphate to 0.262mg/L showed that water hyacinth has successfully absorbed phosphate from the polluted water. (See fig 7 and table 3).

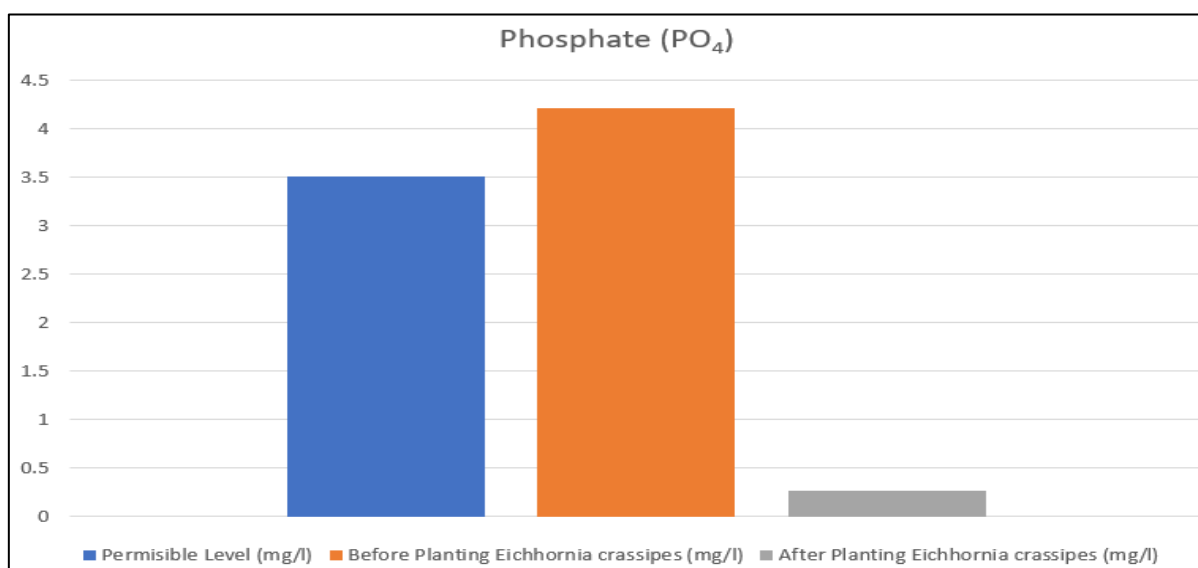


Fig 8 Graph Showing the Concentration of Phosphate in the Water Before and After the Experiment

➤ *Nitrate Removal*

The initial level of nitrate in wastewater was about 11.063± 2.82 mg/l which was higher than the permissible

level 10mg/l. In 21 days, nitrate was reduced to 0.135mg/l, this shows that water hyacinth reduced nitrate to a greater extent. (See fig.7 and table3).

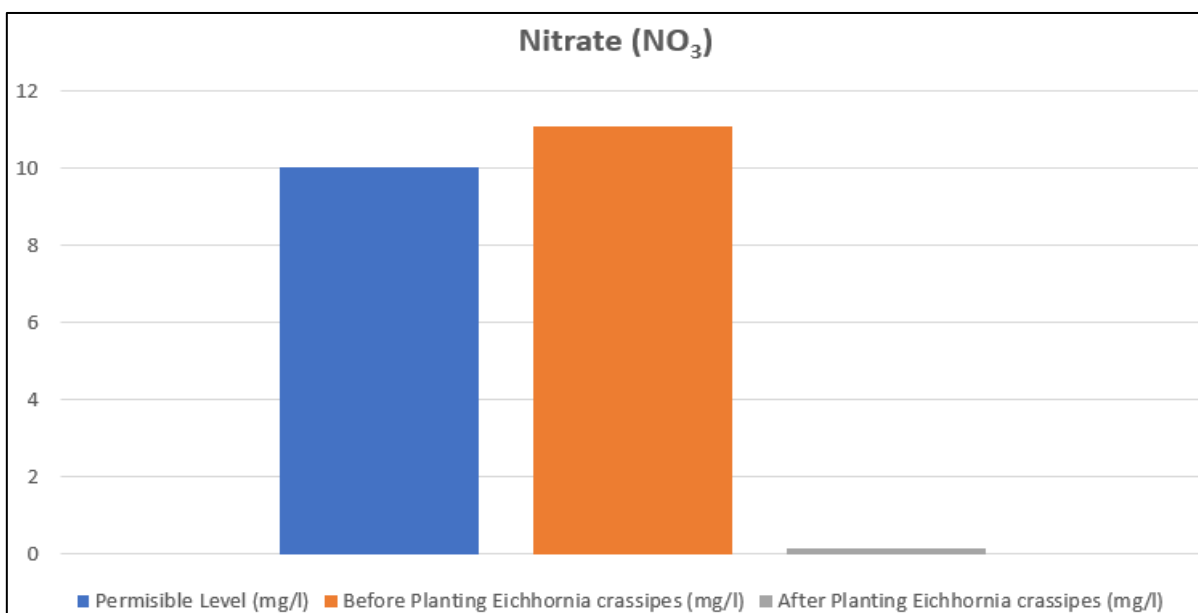


Fig 9 Graph Showing the Concentration of Nitrate (NO₃) in the Water Before and After the Experiment

➤ *Silicate Removal*

The initial concentration of silicate in the polluted water was 6.018 ± 1.26 mg/l and was reduced to 0.827 by

the plants after 21 days. This revealed the ability of the water hyacinth to absorb silicate in polluted water. (See fig 7 and table 3).

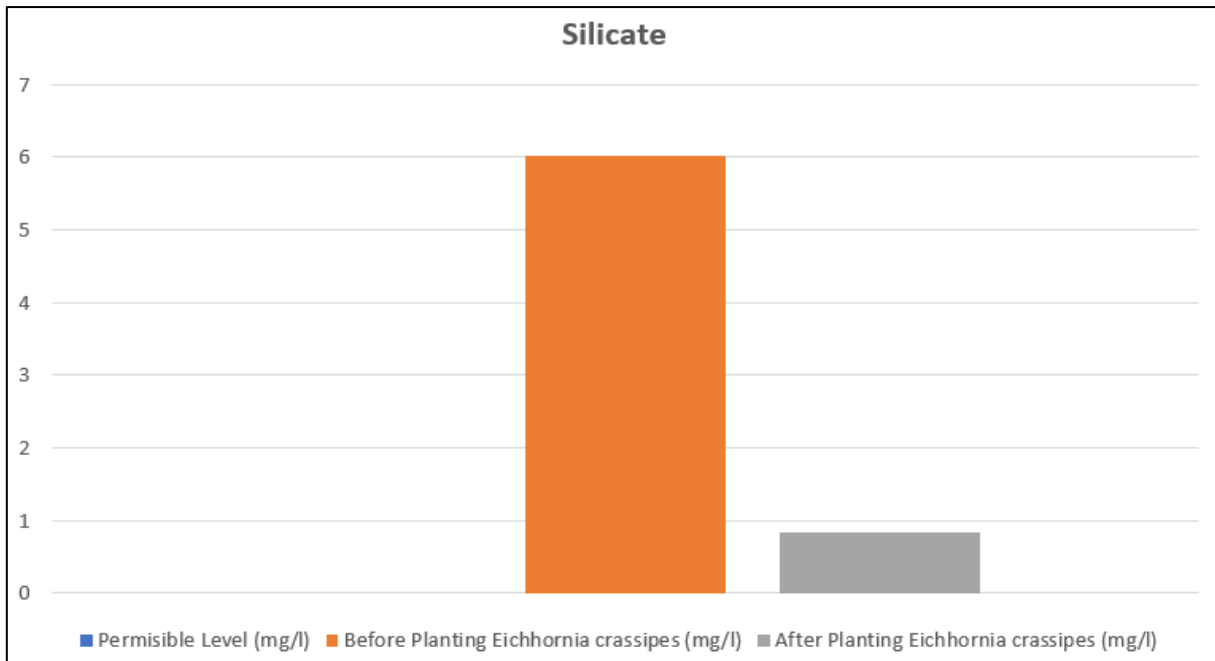


Fig 10 Graph Showing the Concentration of Silicate in the Water Before and After the Experiment

➤ *Lead Addition*

The initial level of Pb in the wastewater was 0.602 ± 0.13 mg/l which is higher than the permissible level of 0.05mg/l. During the 21 days period lead (Pb) increased to

1.013mg/l. This could be attributed to the atmospheric deposition or the sand used for the planting of the water hyacinth (table 3).

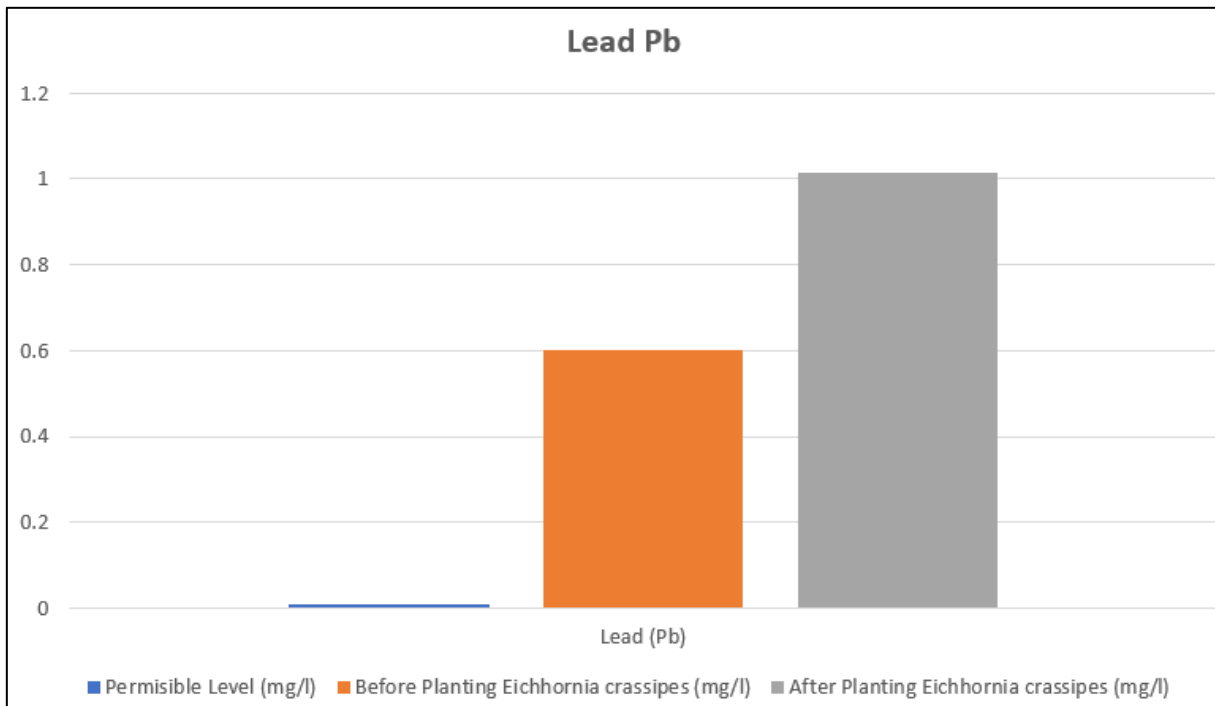


Fig 11 Graph Showing the Concentration of Lead (Pb) in the Water Before and After the Experiment

➤ *Iron Removal*

The initial level of Fe in wastewater is 2.024 ± 0.44 mg/l which is much higher than permissible level of

1.0mg/l. In 21 days, iron was reduced to 0.986mg/l, this revealed that water hyacinth absorbed iron from the wastewater. (See fig 7 and table 3).

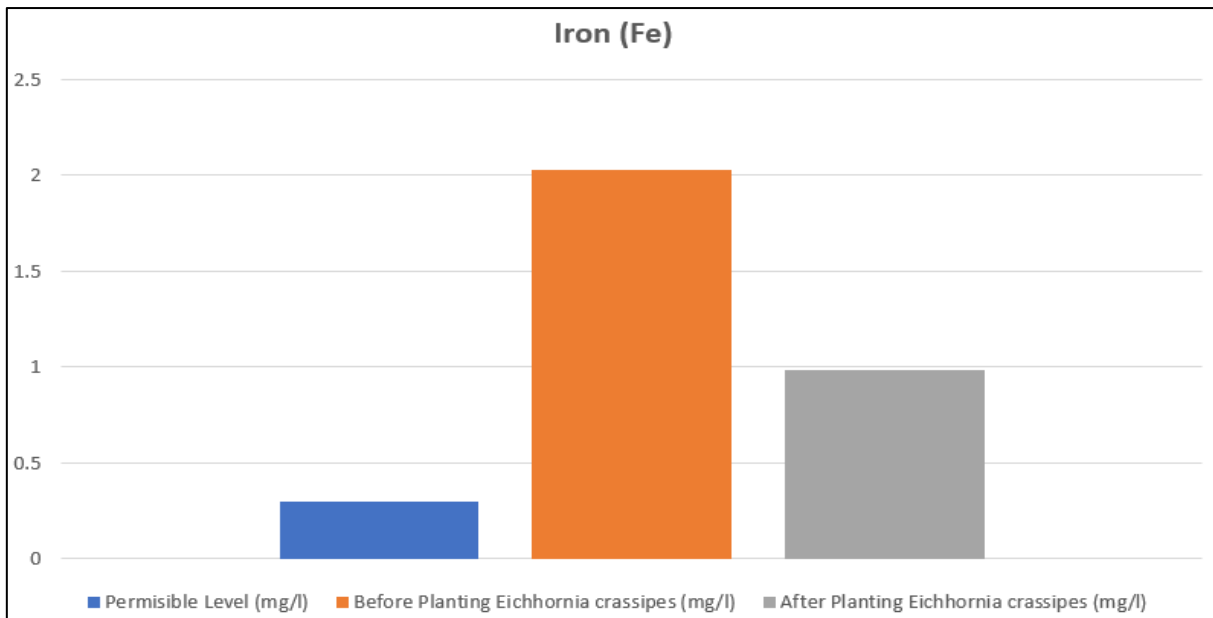


Fig 12 Graph Showing the Concentration of Iron (Fe) in the Water Before and After the Experiment

Vanadium and mercury were below detectable limits of the instrument used.

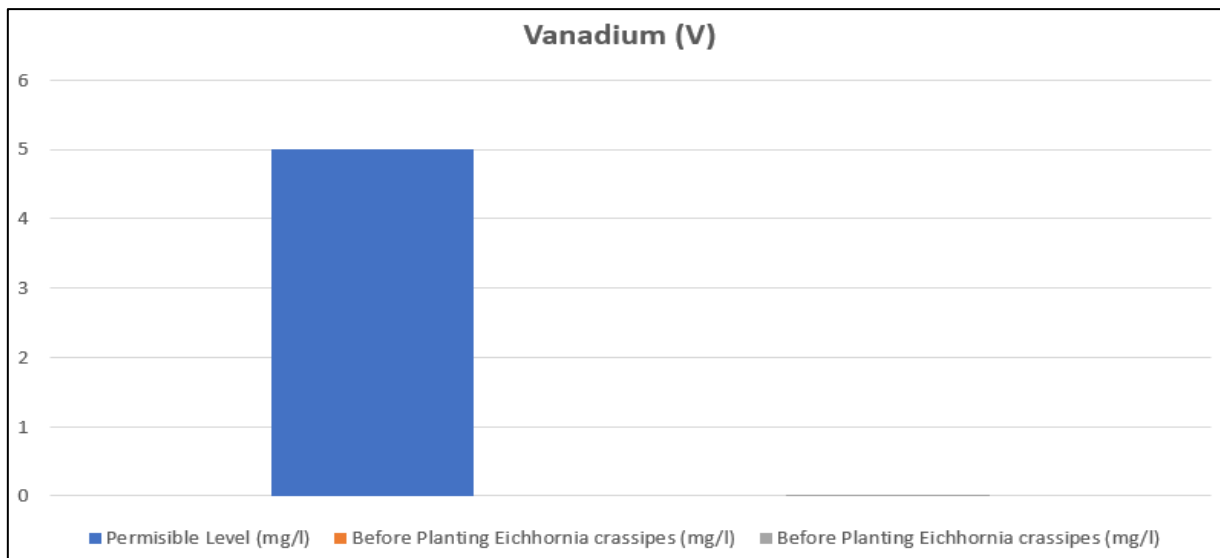


Fig 13 Graph Showing the Concentration of Vanadium (V) in the Water Before and After the Experiment

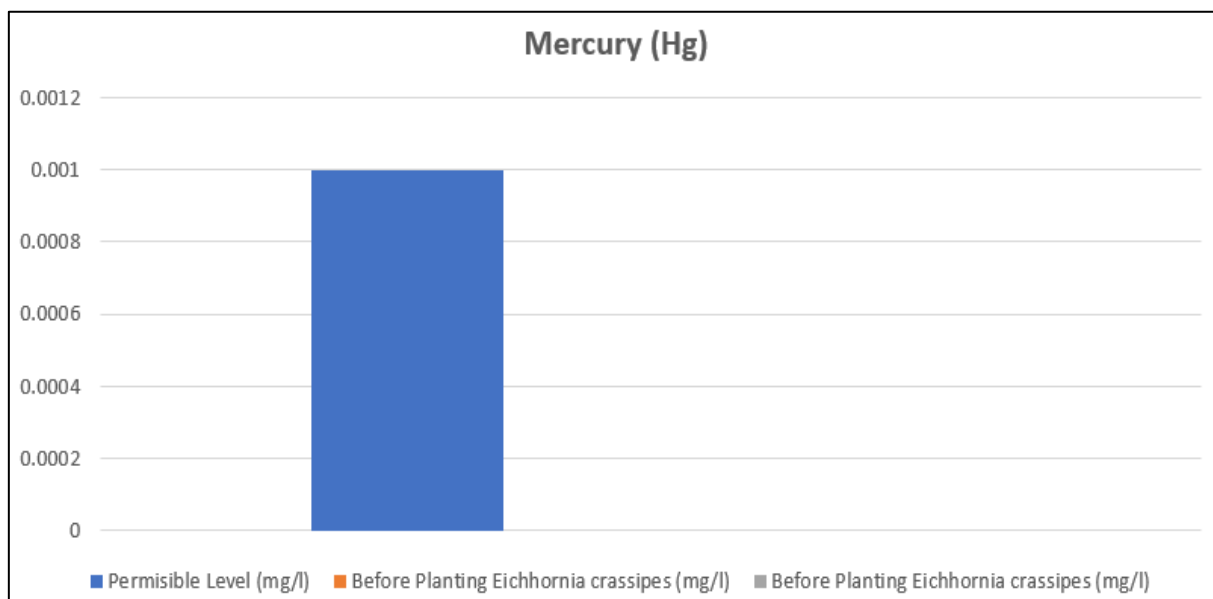


Fig 14 Graph Showing the Concentration of Mercury (Hg) in the Water Before and After the Experiment

➤ *Nickel Removal*

The initial level of Hg in the wastewater was 0.2204 ±0.02mg/l which was higher than permissible level of

0.05mg/l. In 21 days, nickel was reduced to 0.067mg/l, this revealed that water hyacinth absorbed nickel. (See fig 7 and table 3).

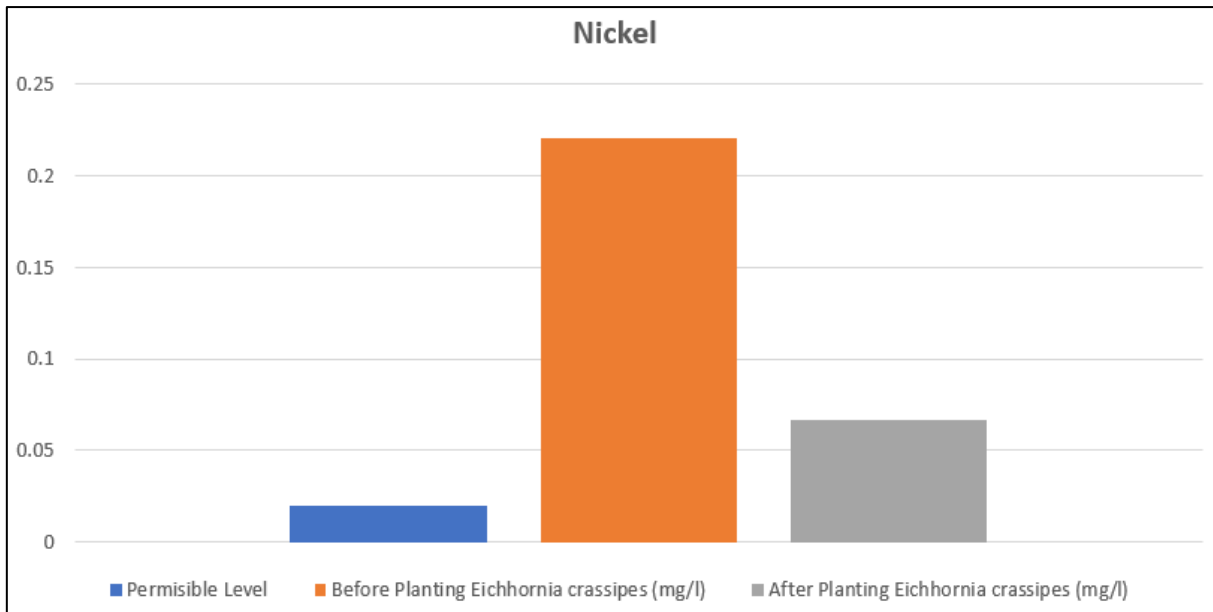


Fig 15 Graph Showing the Concentration of Iron (Fe) in the Water Before and After the Experiment

➤ *Cadmium Removal*

The initial level of Cd in the wastewater was 2.417 ±0.78 mg/l which was higher than permissible level

1.0mg/l. In 21 days, Cd was reduced to 0.568mg/l, indicating that water hyacinth absorbed cadmium. (See fig 4 and table 2).

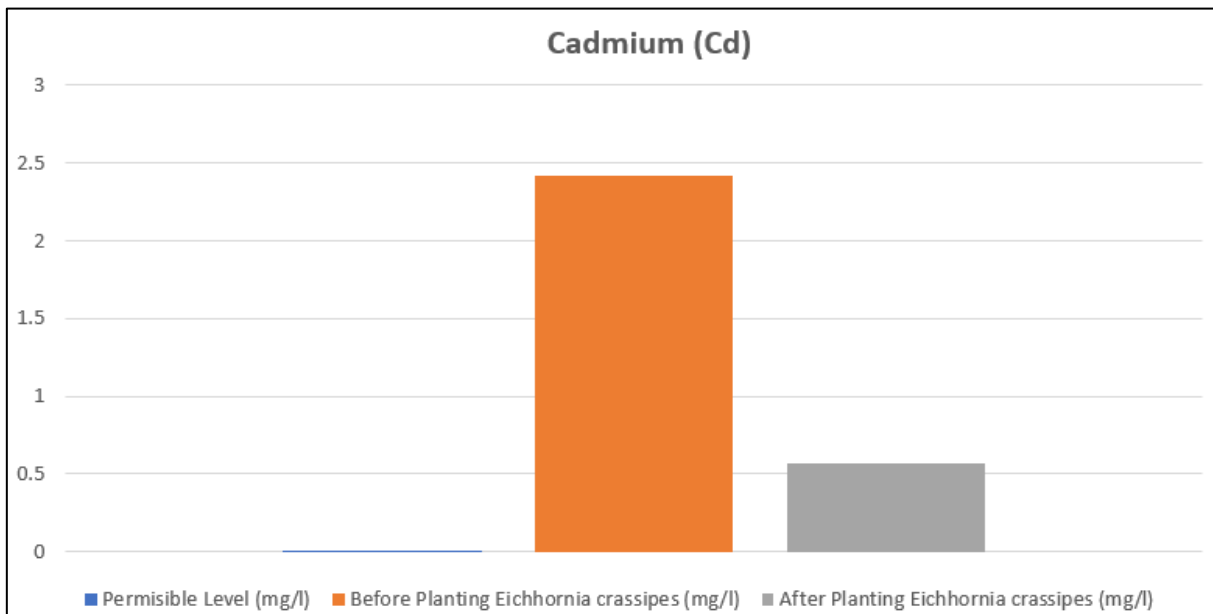


Fig 16 Graph Showing the Concentration of Cadmium (Cd) in the Water Before and After the Experiment

The efficacy of wastewater treatment system was measured by comparing the levels of nitrate, phosphate, silicate, and heavy metals before and after treatment. According to Slak et al. (2005) and Madikizela (2021), water hyacinth can be a significant herbaceous plant in phytoremediation. An abundance of high-quality nutrients, including nitrates and phosphates, are found in household sewage. The natural balance of the environment could be disturbed by nutrients in such massive quantities. A good treatment using water hyacinth might be performed on this sewage before it is released into different bodies of water.

Algae and other creatures may thrive in these nutrients, which could throw off the water body's delicate equilibrium. Though heavy metals have always been present in Earth's crust, human interference with geochemical processes and other natural phenomena has led to elevated concentrations of these elements in aquatic environments through mining. Another possible side effect of being exposed to metals like lead and mercury is the development of autoimmunity, a condition when the immune system assaults its own cells (Sharif & Amital, 2024). Rheumatoid arthritis and other autoimmune

illnesses can develop, along with kidney, cardiovascular, neurological, and foetal brain problems.

Heavy metals like iron, copper, and zinc are necessary for life in small doses; nevertheless, they pose health risks at higher concentrations due to their inability to biodegrade and propensity to bioaccumulate (Crini, 2005). So, it's crucial to lessen the water's nutrition and

metal content. The use of water hyacinth helped remove nutrients and metals. There was a dramatic improvement in water quality once the plants were grown in close proximity to one another.

Water hyacinth was found to be capable of removing excess nutrients and heavy metals by an estimated 75% according to the trial results (Fig. 17)

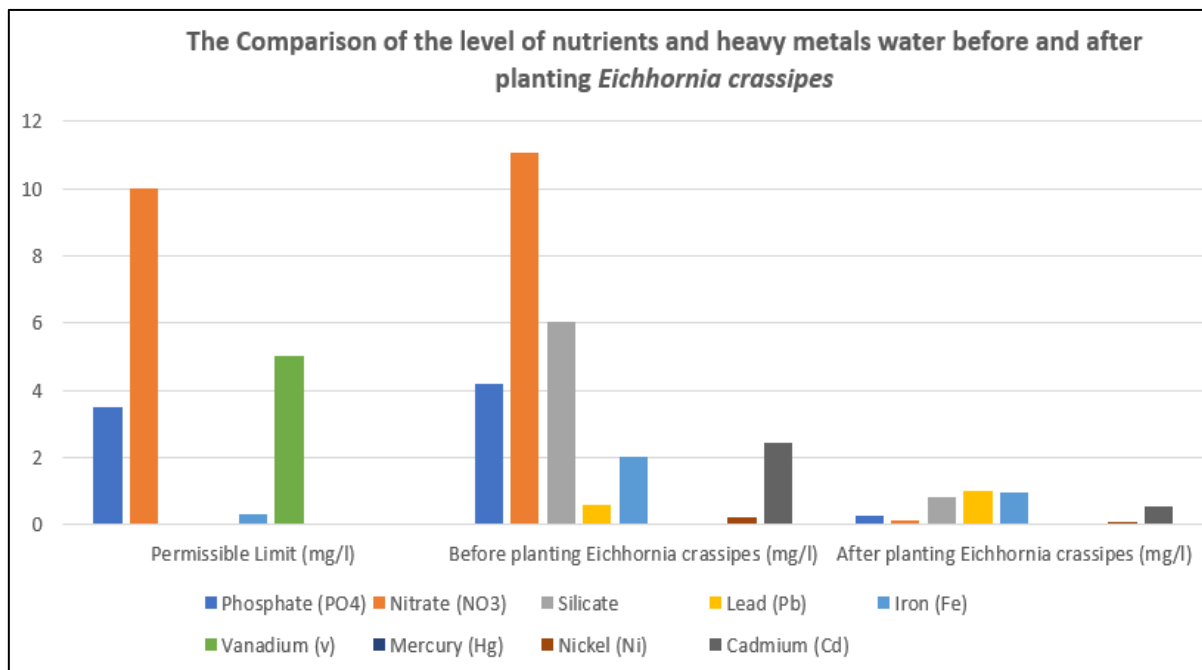


Fig 17 Graph Showing the Comparison of the Level of Nutrients and Heavy Metals Water Before and After Planting *Eichhornia crassipes*

According to Ahmad, *et al* (2025), water hyacinth (*E. crassipes*) uses its extraordinary ability to absorb and filter impurities like heavy metals, surplus nutrients, and organic contaminants to provide a sustainable and all-natural way to improve water quality. By lowering toxic compounds and increasing oxygen levels, this aquatic plant effectively reduces water pollution through phytoremediation. Particularly in areas without easy access to traditional purification methods, its remarkable growth and flexibility make it a practical and affordable choice for treating wastewater.

IV. SUMMARY

This system of treatment was economical because it required little in the way of upkeep and installation. After treating the polluted water using water hyacinth (*Eichhornia crassipes*), the surplus nutrients and heavy metals were successfully eliminated, as shown in the before and after comparisons. It is possible to treat with this system. *Eichhornia crassipes* and other aquatic plants can be used in a "sustainable" and environmentally beneficial way to clean wastewater, as shown in this study. Future large-scale investigations should concentrate on phytoremediation of contaminated water and phytoextraction of surplus nutrients and heavy metals from a dead zone, as this study was just a laboratory-scale baseline.

V. CONCLUSION

The results showed that water hyacinth, (*Eichhornia crassipes*) plants was able to absorb excess nutrients such as nitrate, phosphate, silicate and heavy metals e.g. iron, nickel and vanadium from the polluted water and can play crucial roles in water purification. If Water hyacinth is planted at the river banks where activities that could pollute the water bodies are carried out, it could absorb these pollutants especially the excess nutrients that are capable of causing eutrophication in the freshwater bodies. It can also be used for phytoextraction in dead zones due to eutrophication.

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