PHYTOACCUMULATION OF CHROMIUM (VI) USING *Ipomoea aquatica* (KANGKUNG AIR)

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APPROVAL

"We hereby declare that we have read this thesis and in our opinion this thesis is sufficient in terms of scope and quality for the award of the degree of Bachelor of Applied Science (Sustainable Science) with Honours"

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DECLARATION

I declare that this thesis entitled "Phytoaccumulation of Chromium (VI) Using *Ipomoea Aquatica* (Kangkung Air)" is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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PHYTOACCUMULATION OF CHROMIUM (VI) USING *Ipomoea aquatica* (KANGKUNG AIR)

ABSTRACT

Treatment and disposal of heavy metal in the industrial effluents, especially in wastewater is a major concern to the environmentalists. One of such polluting heavy metal is hexavalent chromium, Cr (VI), which is emanated from tanning and metal processing industries and is accepted as carcinogen. The toxic hexavalent chromium is highly mobile where as its trivalent counterpart, Cr (III) is less mobile and less toxic. Hence, treatment of hexavalent chromium requires a reduction process. Most of chemical reduction processes with precipitation generates a huge quantity of sludge which are difficult to dispose of and causing secondary pollution to the environment. The research is about reducing hexavalent chromium present in the *Ipomoea aquatic* (water spinach) plant. The phytoremediation technology is used to treat the contaminated water containing higher amount of chromium. In this study, *Ipomoea aquatic* has been used to remediate the chromium contaminated water. The accumulation of chromium and removal efficiency of chromium by *Ipomoea aquatic* was carried out in this research. Potassium dichromate solution was directly added to the water in each experimental pot at three different wetland reactor with chromium concentration levels from 0, 20 and 50 mg/L. In this work, Cr in the *Ipomoea aquatic* (water spinach) plant were analysed accordingly, through Atomic Absorption Spectrophotometer (AAS) using dilution method. Based on the results obtained, it can be concluded that *Ipomoea aquatic* can accumulate chromium in leaves, stems and roots.

KAJIAN FITOAKUMULASI *Ipomoea Aquatica* (KANGKUNG AIR) BAGI ION KROMIUM (VI)

ABSTRAK

Rawatan dan pembuangan logam berat yang terkandung didalam sisa buangan industri terutamanya didalam air sisa buangan merupakan masalah utama yang membimbangkan seseorang yang mengambil berat atau menganjurkan perlindungan alam sekitar. Salah satu logam berat yang mencemarkan alam sekitar adalah kromium heksavalen, Cr (VI), yang dihasilkan daripada industri penyamakan dan industri pemprosesan logam dan diterima sebagai karsinogen. Kromium heksavalen toksik sangat mudah alih di mana-mana sebagai kromium trivalen, Cr (III) adalah kurang mudah alih dan kurang bertoksik. Oleh itu, rawatan kromium heksavalen memerlukan proses pengurangan. Kebanyakan proses pengurangan kimia dengan curahan hujan menghasilkan kuantiti cernap cemar yang sangat sukar untuk dibuang dan menyebabkan pencemaran sekunder terhadap alam sekitar.Kajian ini adalah mengenai mengurangkan kromium heksavalen di dalam tumbuhan *Ipomoea akuatik* (Kangkung air).Teknologi fitoremediasi digunakan untuk merawat air tercemar yang mengandungi jumlah kromium yang lebih tinggi. Dalam kajian ini, tumbuhan *Ipomoea aquatik* telah digunakan untuk menstabilkan air kromium yang tercemar. Pengumpulan kromium dan penyingkiran kecekapan kromium oleh *Ipomoea* akuatik telah dijalankan dalam kajian ini. Larutan kalium dikichromat secara langsung ditambah kepada air dalam setiap periuk eksperimen di tiga reaktor tanah lembap yang berlainan dengan tahap kepekatan kromium dari 0, 20 dan 50 mg / L. Dalam kerja ini, Cr dalam tumbuhan *Ipomoea akuatik* (bayam air) dianalisis dengan sewajarnya melalui Spectrophotometer Atomic Absorption (AAS) menggunakan kaedah pencairan. Berdasarkan keputusan yang diperolehi, dapat disimpulkan bahawa *Ipomea akuatik* boleh mengumpul kromium dalam daun, batang dan akar.

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LIST OF ABBREVIATION

Cr (VI)	Chromium Hexavalent (VI)
AAS	Atomic absorption spectroscopy
HNO_3	Nitric Acid
H_2O_2	Hydrogen peroxide

LIST OF SYMBOLS

%	percent
mg/l	milligram/litre
ppm	part per million

LIST OF EQUATION

$$\% \text{ removal efficiency } = \frac{\text{influent (mg/L) - effluent (mg/L)}}{\text{influent (mg/L)}} \times 100\%$$

CHAPTER 1

INTRODUCTION

1.1 Background of Study

The rapid industrialization in developing countries with an enormous and increasing demand for heavy metals has resulted into high anthropogenic emission of these pollutants into the environment (Bindu et al., 2010). The example of the pollutants are wastewater from many sources whether natural or anthropogenic sources from the human activities. There were many heavy metals that have been contaminant the sources. Therefore, Chromium is one of the heavy metal that pollutes the environment.

Chromium has been considered as one of the top 16th toxic pollutants and because of its carcinogenic and teratogenicity characteristics on the public, it has become a serious health concern, (Z Kwolski, 1994). Cr (VI) is more mobile and toxic than Cr (III). Hence, Cr (VI) is more important than Cr (III) in water pollution control. According to the World Health Organization (WHO) drinking water guidelines, the maximum allowable limit for hexavalent chromium and total chromium (including Cr(III), Cr(VI) and other forms) are 0.05 and 2 mg/L, respectively, (A.Baral, 2002).

The mobile Cr (VI) species are carcinogenic and mutagenic to living organisms, (Nakajima, A., Baha, 2004).It is therefore essential to remove Cr (VI) from wastewater before disposal. Traditional chromium treatment technologies include ion exchange, chemical reduction/ precipitation, membrane separation, and adsorption. These methods are often very costly, requiring high energy input or large quantities of chemical reagents (G. Donmez, 2002). With the technology development, chromium could been treated with a low energy input with a small amount of chemical reagents. Industries activities in urban area leads most of heavy metals like lead, magnesium, chromium, contamination including textile production, sewage sludge, fly ash, metal plating and wood processing goods.

Ipomoea aquatic sp is a submerged aquatic plant, grown in drainage channels, marshes, and fields. It is grown throughout the year, abundance and low cost. It is widely used in some parts of the world as a leafy vegetable for human consumption, (Vara Prasad & Freitas, 1999). These aquatic plant were easy to be found. The suitable habitats for these plant are the place with a wet and humid condition.There is not much data available on the accumulation of Cr (VI) or other metal ions on. *Ipomoea aquatic* or allied species in the literature. Hence, a study on chromium hexavalent Cr (VI) with *Ipomoea aquatic* (Water Spinach) had been conducted for this study.

1.2 Problem statement

Water source are important to human. Water is importance in our daily lives. Therefore, the need to enhance and preserve its quality is growing continuously. Point and non-point sources are contaminating our valuable water resources. The sources should be preserve for the environment. The water source remains clean and clear for the human consumption. The main water pollution sources are from industrial, domestic and agricultural activities and other environmental and global changes.

The contamination of chromium (VI) effect the water resource. The pollution of water due to heavy metal contamination would reduce the water availability. High demand of clean water resources from local people to the authority. The contaminated water would affect the human health by the consumption of the water from the polluted area.

In this study, *Ipomoea aquatic* is suggested to treat water contaminated with chromium (VI) via accumulation process with plant.

1.3 Justification

The *Ipomoea aquatic* sp. is potential accumulator to remove chromium (VI) metal in water. There is lack of study involving accumulation of heavy metal to treat water pollution by aquatic plant.

1.4 Objective

The aims of this study conducted are:

1. To determine the capability of *Ipomoea aquatic* sp. (water spinach) to accumulate chromium (VI)
2. To study the parameter affecting phytoaccumulation of chromium (VI) using *Ipomoea aquatic* sp.

1.5 Expected outcomes

This study expected to achieve successful accumulation of chromium (VI) by *Ipomoea aquatica* sp.

1.6 Scope of study

The study begin by constructing a constructed wetland reactor model for the *Ipomoea Aquatic* sp. The achievement of the study had been analyzed in term of accumulation of chromium in *Ipomoea aquatica* sp. the final accumulation of chromium will be manipulated using two variables which are hydraulic retention time (HRT) and concentration of chromium.

1.7 Significant of study

This study can be used by other researcher to get information on the ability *Ipomoea Aquatica* sp. to treat chromium from water. This study will prove the capability of water spinach to heavy metals. Beside, *Ipomoea Aquatic* sp. can't be consumed by human. Contaminated plants are bad for human and animal. It can cause unexpected diseases.

By end of this project, the findings might be useful to develop phytoremediation.

CHAPTER 2

LITERATURE REVIEW

2.1 *Ipomoea aquatic* sp

Phytochemical screening of water spinach revealed high concentrations of alkaloids, reducing sugar, soluble carbohydrate, flavonoids, while it contained lower concentrations of steroids, phenols, glycosides, β-carotene, saponins and tannins (Igwenyi et al., 2011), having the mineral, vitamin and carbohydrate contents showed that the plant consists material can be a good source of nutrient for human and animal food intake. Besides, the plant having a serious pharmacological and therapeutic effect compare to the nutritional essence.

The plant usually found at the Southeast Asia region (Göthberg, Agneta, Maria Greger, 2002). The suitable habitats for these plant are the place with a wet and humid condition. The common names for this plant are *Ipomoea aquatica* is the oldest preferred scientific name among others since 1775. Swamp morning-glory is also another preferred common name. When comes to international common names, *Ipomoea aquatica* have names like water spinach (English), kongxin cai (Mandarin), batata acuática (Spanish), patate aquatique (French), you-sai (Japanese) and lastly batata aquática (Portuguese), (Liang, 2017). There were many names of this plant from each country.

This plant have many uses such as serves for humans' foods and medicines for living organisms. The young stem and leaves are usually cooked with a little bit of cooking oil and people would eaten in various dishes as culinary purposes.

For medicine purposes, village people would use this plants as one of their medicine routine consumption as their traditional ancestors way to keep their body healthy and strong.(Liang, 2017) state *Ipomoea aquatica* buds can also use as plant material that can effectively deal with skin diseases such as athlete's foot and ringworm. Boiled *Ipomoea aquatica* juice can prevent constipation and treat fever due to the fibers within this plants are one of the potential plant for curing diabetes or cancer.

2.2 Accumulation of heavy metal

The uptake of copper, zinc, nickel and chromium from nutrient solutions enriched with these metals using Ipomoea aquatic was studied by (Low & Lee, 1981).This aquatic plant demonstrated the ability to remove copper and nickel rapidly and to remove zinc and chromium less rapidly by root absorption and concentration, (Low & Lee, 1981).The *Ipomoea Aquatic* sp. will resist well to copper, zinc, nickel and chromium.

Hyper accumulator is the agent for the accumulation of any heavy metal in the contaminated pollutant. (Liang, 2017), hyper accumulator defines the internal ability of plants to accumulate and store massive amount of toxic heavy metals from medium like soil and water. Eventually, it will have the tendency to withstand the phytotoxic effect after exposed to high amount of heavy metals or toxic substances in the contaminated pollutant. By reuptake of the heavy metal, plant use for the remediation should resistance to the highly concentration of these pollutants.

Metal accumulations by macrophytes can be affected by metal concentrations in water and sediments. (Sukumaran, 2013), the diffusive metal concentration in water is the major factor influencing the metal uptake efficiency. In general, when the metal concentration in water increases, the amount of metal accumulation in plants also increases. The heavy metal concentrations in various effluents from the industries activities in the urban area were comparatively higher. The increased salinity of the pollutant would induces protective mechanisms, which influence the ability of the plant to bio accumulate metals. The effects of heavy metal to the growth of plant.

Since heavy metal tolerance in plants is often species and metal specific, different plants can better accumulate heavy metals in the different plant tissues or cell organelles. Examination of heavy metal accumulating plants.

2.3 Phytoremediation of heavy metal using *Ipomoea Aquatic* sp.

Phytoremediation can be defined as the process of using plants to absorb, accumulate, detoxify and for render harmless, contaminants in the environment through physical, chemical or biological processes (Sukumaran, 2013).Phytoremediation itself is a set of organic technologies with low budget in both capital and operation, which predominantly operate with various plant species with an aim to 'clean' up the contaminated site due to uncontrolled leaching of heavy metals, (Liang, 2017). It is one of the low cost technologies to clean the contaminated pollutant in the contaminated area. Phytoremediation is a biological technology using plants to remove contaminants from water and soils has been intensively studied during the past decade due to its cost effectiveness and environmental harmonies, (Ahmad, Ghufran, & Zularisam, 2011). This technology are suits for the removal of chemical pollutant as it has been intensively used by researchers around the world.

By taking a case study from Thailand, *Ipomoea aquatic* sp. accumulation towards heavy metal is feasible. The water bodies where *Ipomoea aquatic* sp. grow, usually are area of domestic and other wastewater purposes, (Göthberg, Agneta, Maria Greger, 2002). The *Ipomoea aquatic* were found to have concentration of methyl mercury, lead and cadmium.

Phytochemical screening of green kangkung revealed high concentrations of alkaloids, reducing sugar, soluble carbohydrate, flavonoids, while it contained lower concentrations of steroids, phenols, glycosides, β-carotene, saponins and tannins(Igwenyi et al., 2011), having the mineral, vitamin and carbohydrate contents showed that the plant consists material can be a good source of nutrient for human and animal food intake. Besides, the phytochemical of the natural endowments showed the plant have a serious pharmacological and therapeutic effects apart from its nutritional essence.

2.4 Hyper accumulator Plant

Hyper accumulator plant species aggregate the harmful metals above certain of the concentrations in their shoot, leaf and fruits (Sukumaran, 2013). One of the characteristics for a plant to been use as hyper accumulator plant are plant that are able to take up large amounts of metals in their shoots without showing significant signs of toxicity.

Hence, these characteristic would makes hyper accumulators ideal candidates for metal phytoremediation and phytomining. The phytoaccumulation of metals does not depend on the expression of detoxification genes and metal transporters provided by the plant and the bioavailability of the metals in soil. (Thijs, Langill, & Vangronsveld, 2017). However , there were some major drawback limit the application of hyper accumulator for phytoextraction and phytomining, which including slow growth, low biomass production, variable metal uptake under field conditions and thus variation in the accumulation of trace metals in the tissues (Gerhardt, Huang, Glick, & Greenberg, 2009). Indeed, metal-tolerant plants alone cannot sustain in contaminated polluted areas. These selected plants search for constraints to show their action under extreme conditions such as lack of essential nutrients and high contaminant level.

These factors considerably were able to reduce the efficiency of hyper accumulators for metal phytoextraction. Therefore, it is important for the phytoextraction process to increasing the growth of hyper accumulator plants to yield higher biomass, increase plant tolerance, metal accumulation, and survival under field uncertainties under the physicochemical soil conditions in the course of time. Hence, it is proved that the major revolution in metal hyper accumulation is only related to plant genetic traits has been revised and their genes are very likely to explain together the observed hyper accumulator plant phenotype.

2.5 Atomic absorption spectroscopy (AAS)

Atomic absorption spectroscopy (AAS) has emerged as a powerful analytical technique in estimating various atoms by the measurement of light energy of specific wavelength.(Sudunagunta, 2012), it shown that usually there were three different analytical techniques such as atomic emission, atomic absorption and atomic fluorescence. The AAS were able to measure and trace concentrations of various elements with higher degree of sensitivity and precision. Hence, AAS possesses considerable position in the modern analytical laboratories. The present studies highlights the various components of atomic absorption spectrophotometer, different types of AAS and applications of atomic absorption spectroscopy in various fields such as environmental, forensic, geological, biological, pharmaceuticals, food and marine applications. The fate of atomic absorption spectrometry (AAS) as an analytical technique were apparently darkened at the beginning of the 1990s due to the spectacular development of plasma-based instruments and reduction on price that involved the optical emission or mass measurements(López-García & Hernández-Córdoba, 2015).

CHAPTER 3

MATERIALS AND METHODOLOGY

3.1 Preparation of *Ipomoea aquatic*

The seed had been planted and grown in a pot tray within three weeks. The *Ipomoea aquatic* would be harvest after the water collected in a period of time. The healthier plant sample with the same plant size were selected and used for research. The plant lives for 4 weeks in a laboratory scale reactor for the project purposes only.

3.2 Preparation of Chromium (VI) Synthetic Solution

Analytical grade of potassium dichromate ($K_2Cr_2O_7$) was used as synthetic wastewater samples in the experiment. A stock solution of Cr (VI) was prepared by dissolving 2.829g of potassium dichromate salt, $K_2Cr_2O_7$ in 1000ml of distilled water. The stock solution had been undergo serial dilution and diluted to the required concentrations i.e. 20, 50 mg/L. This solution were prepared for the plant and poured into each reactor.

3.3 Wetland Preparation

Ipomoea aquatic plant had been placed in a constructed wetland reactor. There were three set of reactor. Two of them had been planted with *Ipomoea aquatic* and the other one will act as control tank without *Ipomoea aquatic*. The media in the wetland had been consist of pebbles and soil. The reactor were placed under a shady place to avoid over exposure of UV light from the sunlight and the rain water entering the reactor.

Ipomoea aquatic plant were placed in a constructed wetland. By the previous research, (Sukumaran, 2013) stated that Constructed Wetland (CW) is an artificial wetland created as a new habitat for native and migratory wildlife, for anthropogenic discharge such as wastewater or sewage treatment and or other ecological disturbances such as required mitigation for natural areas lost to a development. The wetland would consists of three reactor include the control reactor for the plants consists of media of soils and pebbles. It acts as a bio filter, removing sediments and pollutants such as heavy metals from the water, and constructed wetlands had been design for this final project purposes.

3.4 Plant analysis preparation

The plant samples had been washed by using tap water followed by distilled water to remove the impurities. The excess water had been removed by using filter paper. The sample plants had been separated into three parts which leaves, stems and roots.

The sample plants had been cut into small pieces using knife and blender. The sample plants had been oven dried in 80ºC for 12 hours until completely dried. The dried plant samples had been grounded into powder form by using mortar and pestle.

The powdered dried plants undergoes acid digestion for the extraction purposes. They were mixed with nitric acid, HNO3 (65%) and slowly added hydrogen peroxide, H_2O_2 (30%) in the fume cupboard. The sample were heated for seven to eight minutes on a hot plate until strong bubble were produced. The solution were cooled in the fume cupboard before its ready to be filtered by using filter paper. For testing the solution using the atomic absorption spectrophotometer (AAS), the solution were also filtered with syringe filter to remove impurities before using the AAS. Technique used for AAS were AA flame that are suitable for identify the chromium concentration in the solution.

3.5 Effect of Contact Time with Different Concentrations of Cr (VI)

The optimum contact time for phytoremediation using constructed wetland had been studied for this experiment with different concentrations of Cr (VI) wastewater i.e.20, 50 mg/L. The effluents had been collected every day from day 1 until day 10. The final readings of Cr (VI) had been taken until the removal percentage become constant. The initial and final readings of Cr (VI) wastewater concentration had been analysed using Atomic absorption spectroscopy (AAS).

CHAPTER 4

RESULT AND DISCUSSIONS

4.1 Effect of Contact Time with Different Concentrations of Cr (VI)

Samples were diluted before being analyzed. There were prepared standard chromium solutions for comparison and the absorbance of each solution was measured. A collected water sample was also prepared after been collected from the wetland reactor. 10 mL of this prepared water sample was placed in a 100 mL volumetric flask and enough water was added to make it up to the mark. The absorbance of this diluted water sample was recorded.

In research, the water samples were collected from the three wetland reactor for 4 different times for each reactor. The water sample were then filtered with a filter paper and transferred into a beaker. The filtered solution undergoes three times dilution with distilled water and analysed by atomic absorption spectrophotometer.

$$\%\ \text{removal efficiency} = \frac{\text{influent (mg/L) - effluent (mg/L)}}{\text{influent (mg/L)}} \times 100\%$$

Table 4.1 and table 4.2 shown the mean result from the water samples collected from three different reactor for different days were analyzed by using the atomic absorption spectrophotometer (AAS) along 40 days of experiment.

Table 4.1: the percentage removal for the 20 ppm initial concentration of chromium

Day	Calculated concentration (mg/L)- Sample	Calculated concentration (mg/L) - Control	Percentage removal (%)
1st	1.469	4.418	66.74
4th	0.143	4.418	96.76
15th	0.052	4.418	98.82
16th	0.082	4.418	98.14

Table 4.2: the percentage removal for the 50 ppm initial concentration of chromium

Day	Calculated concentration (ppm)	Calculated concentration (ppm)	Percentage removal (%)
1st	4.200	4.418	04.93
4th	2.303	4.418	47.87
15th	1.178	4.418	73.34
16th	2.136	4.418	51.65

Water and soil were among the two mediums that have directly and close contact with the plant. Therefore, both mediums show a very crucial role to identify the Cr accumulation in the plant parts. For the water mediums, it shown in the result from the 20 ppm initial concentration of chromium that on the 15th days have the highest percentage removal with the value of 98.82% while on the first day have the lowest percentage removal which is 66.74 %. Next, the highest percentage removal for the 50 ppm initial concentration of chromium is 73.34% on the 15th days and the lowest percentage removal is 04.93% on the first day of water collected from the wetland reactor. It can explained that the plant accumulate more over time. Hence, this can be explained that *Ipomoea aquatica* shows a certain characteristic on the limit of accumulation capacity within the plant itself, whereas the full remediation potential of *Ipomoea aquatica* has been limited due to the limited time given to the experiment.

4.2 Plant analysis

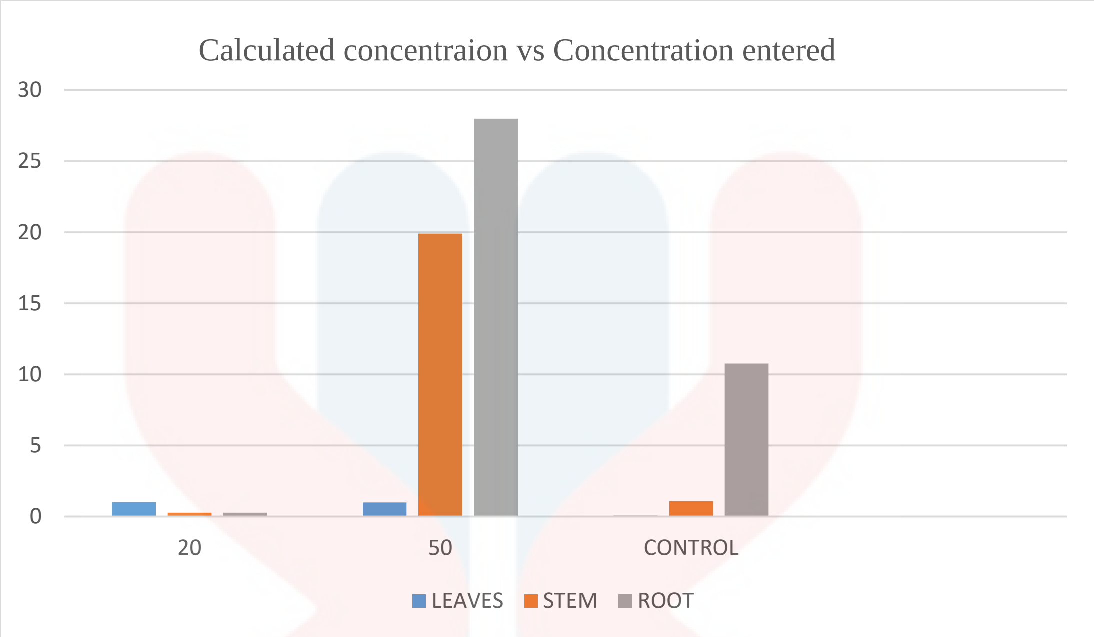
As for the plant samples, each plant were cut into three parts which is leaves, stem, and roots. From the reactor, the plant were removed by hand and washed by the tap water to remove the impurities. Next, the plant were cut by knives and place under a hot sunny day before place into the oven. The dried plants were pounded using mortar and pestle until the dried plants turns into powdered form. Figure 4.1 show the wetland reactor consists of *Ipomoea aquatic* plant and figure 4.2 show the arrangement of segmented plant parts before oven them.

Figure 4.1 Three Wetland Rector

Figure 4.2 Harvested *Ipomoea aquatic* plant from the reactor

Table 4.3 show the concentration of chromium in leaves, stem and root of *Ipomoea aquatic.*

Plant	Reactor		
	A (mg/L)	B (mg/L)	C (mg/L)
Leaves	1.017	0.980	0.055
Stem	0.271	19.91	1.070
Root	10.77	27.98	0.257



It is show that leaves from plant in reactor A consists the highest amount of chromium compared to plant in reactor B and the control plant. The highest value are 1.017 mg/L. The factor that may contributes to this condition are the weather and the climate at the surrounding of the plant in the reactor. The rainwater effect the transpiration of the plants. While the lowest value is 0.055 mg/L which are collected from the control tank acts as the control for this experiment.

The plant reactor B were poured with 50 ppm of synthetic chromium had the highest amount of chromium in the stem parts which is 19.91 mg/L. The lowest amount of chromium in the stem parts is from the reactor A which is the value are 0.271 mg/L. as the leaves from plant A accumulate more chromium, the stem gets fewer amount of chromium to be accumulate. It is the same for the root parts.

Roots from the plant in reactor B have the highest concentration of chromium which is 27.98 mg/L while the lowest concentration of chromium from the roots in the plant in reactor C with the value of 0.257 mg/L. as for the reactor A, the concentration of chromium in the roots are 10.77 mg/L.

Therefore, it can be concluded that *Ipomoea aquatic* can accumulate chromium in leaves, stems and roots.

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 Conclusion

Overview of the result obtained, it is show that the percentage removal for the 20ppm are higher compared to the percentage removal for the 50ppm. The digestion of plant sample show that the concentration of chromium in plant with 50 ppm are higher compared to the plant with 20 ppm. .The research has indicated water spinach can accumulate chromium within the analyzed water sample collected from the wetland reactor and the plant sample digested with acid to test with AAS.

5.2 Recommendation

Many studies on the use of aquatic plants in removing heavy metals from polluted water have been reported. It would suggested for look for the most common aquatic plant used in the phytoremediation mechanism, which is water hyacinths (*Eichhoris crasspies)*. Water hyacinth is one of the ancient technology that has been still used in the modern era, (Rezania et al., 2015). It is reported that the use of water hyacinths, among other aquatic plants, for the removal of metals, nitrogen and phosphorus from polluted waters. This plants were seek for nutrient absorption has provided way for its usage in phytoremediation, along with the combination of herbicidal control, integrated biological control and watershed management controlling nutrient supply to control its growth(Rezania et al., 2015). Hence for the sake of the future aspects of phytoremediation, the utilization of invasive plants in pollution enhance the phytotechnologies could possibly assist for the sustainable management in treating waste water.

Environment or physical growing conditions is crucial for plant growth and subsequently remediation capability as well. Beside, to improve the capability of *Ipomoea aquatica* plant for accumulate heavy metal from the environment, it would suggested to growing of *Ipomoea aquatica* in a greenhouse with strict observation of dependent variables like water source, soil type and air quality are important.

Besides that, growing of *Ipomoea aquatica* in the water are compared with the one growing in the soil. As naturally *Ipomoea aquatica* is an aquatic plant that able to adapt hypotonic growing method. This is because by doing so, the efficiency of phytoremediation mechanisms like phytoextraction and phytostabilization with phytodesalination and phytofiltration of *Ipomoea aquatica* can be investigated as stated by, (Liang, 2017). Therefore, the *Ipomoea aquatic* are recommended to growth in the water for the best choice for phytoaccumulation process to occur efficiently.

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APPENDICES - A

Figure A .1: The water collected from the reactor

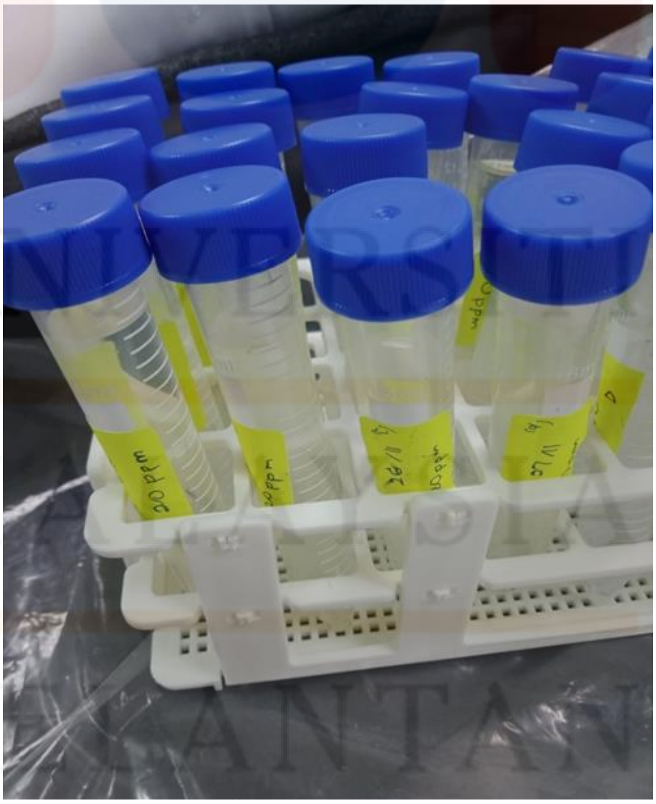

Figure A.2: The Water Sample for AAS Test