UNIVERSITI PUTRA MALAYSIA

SCREENING OF AQUATIC PLANT FOR POTENTIAL PHYTOREMEDIATION OF HEAVY METAL CONTAMINATED WATER

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PENGESAHAN

Dengan ini adalah disahkan bahawa projek yang bertajuk "Screening of Aquatic Plant for Potential Phytoremediation of Heavy Metal Contaminated Water" telah disiapkan serta dikemukakan kepada Jabatan Biokimia oleh Wan Noraina Atikah Bt Wan Mohd Musdek (162587) sebagai syarat kursus BCH 4999 projek.

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ABSTRACT

Bioremediation is a new green economic approach in providing solutions for cleaning up contaminated sites. Phytoremediation is a branch of bioremediation that uses plants as a tool for remediation purposes. The mass amount of contaminants especially heavy metals is a worrying concern to the mass public in recent times. The usage of phytoremediation using plant species offers higher potential solution to remediate heavy metal contaminated sites. This study intended on screening potential plant species for phytoremediation of heavy metal contaminated water. The potential of three aquatic macrophytes species (*Eichorrnia crassipes*, *Pistia stratiotes* and *Ipomoea aquatica*) to be used for chromium and nickel phytoremediation was tested. The plants were exposed for ten days under hydroponic conditions to the designated heavy metals contaminated water in order to assess the suitability of the aquatic plants to remediate the water. The *E. crassipes* showed the highest chromium and nickel concentration detected in plant biomass, 1.60 µg/L and 2.40 µg/L, respectively. Meanwhile, *P. stratiotes* of chromium and nickel concentrations detected were 0.89 µg/L and 0.081 µg/L, respectively; chromium and nickel concentration of *I. aquatica* detected were, 0.49 µg/L and 0.080 µg/L, respectively. The ability of these plants to accumulate metals and survived throughout the experiment demonstrates the potential of these plants to remediate metal enriched water. Among the three tested aquatic plants, *E. crassipes* showed the most suitable plant species that can phytoremediate heavy metal contaminated water followed by *P. stratiotes* and *I. aquatic*a.

ABSTRAK

Bioremediasi adalah pendekatan ekonomik hijau yang baru dalam menyediakan penyelesaian untuk membersihkan tapak yang tercemar. Fitoremediasi adalah satu cabang bioremediasi yang menggunakan tumbuh-tumbuhan sebagai alat untuk tujuan pemulihan. Jumlah bahan tercemar terutamanya logam berat membimbangkan masyarakat am sejak kebelakangan ini. Penggunaan fitoremediasi menggunakan spesis tumbuhan yang mempunyai berpotensi menawarkan penyelesaian untuk memulihkan tapak yang tercemar dengan logam berat. Kajian ini bertujuan untuk menyaring spesies tumbuhan yang berpotensi untuk merawat air yang tercemar dengan logam berat. Tiga spesies makrofit akuatik (*Eichorrnia crassipes*, *Pistia stratiotes* dan *Ipomoea aquatica*) dipilih untuk menguji potensi fitoremediasi tumbuhan. Tumbuhan tersebut didedahkan selama sepuluh hari di dalam sistem hidroponik dengan kepekatan logam berat berbeza untuk menilai kesesuaian tumbuhan akuatik untuk menyerap logam dari air. Keputusan daripada data menunjukkan kromium dan nikel mampu diserap oleh tumbuhan berdasarkan kepekatan logam dalam biomas akar tumbuhan dengan bacaan 1.60 µg / L untuk kromium, dan 2.40 µg/ L untuk nikel. *P. stratiotes* menyerap 0.89 µg/L kepekatan kromium dan 0.081 µg/L kepekatan nikel; *I. aquatica* menyerap 0.49 µg/L kepekatan kromium dan 0.080 µg/L kepekatan nikel. Keupayaan tumbuh-tumbuhan ini untuk mengumpul logam diuji dan kebolehan tumbuhan untuk terus hidup sepanjang eksperimen menunjukkan potensi tumbuhan ini untuk hidup di dalam air berlogam berat. Antara ketiga-tiga tumbuhan akuatik yang diuji, didapati *E. crassipes* merupakan spesis tumbuhan paling sesuai untuk fitoremediasi di dalam air berlogam berat dan diikuti oleh *P. stratiotes* dan *I. aquatica*.

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LIST OF ABBREVIATIONS

%	Percentage
˚C	Degree of Celcius
µg	Microgram
µS	Microsiemens
ADMI	American Dye Manufacture Institute
Al	Aluminium
As	Arsenic
BOD	Biological Oxygen Demand
Ca	Calcium
Cd	Cadmium
cm	Centimeter
Co	Cobalt
COD	Chemical Oxygen Demand
Cr	Chromium
Cr (III)	Chromium trivalent
Cu	Copper
DO	Dissolved Oxygen
DOE	Department of Environment
Fe	Ferum
g	Gram
GCF	Global Contamination Factor
H_2O_2	Hydrogen Peroxide
ha	Hectare
Hg	Mercury
HNO_3	Nitric acid
ICF	Individual Contamination Factors
IWK	Indah Water Konsortium
INWQS	Interim National Water Quality Standards
K	Potassium
kg	Kilogram
L	Liter
mg	Milligram
mL	Milliliter
mm	Millimeter
Mn	Manganese
Na	Sodium
Ni	Nickel
nm	Nanometer
NTU	Nephelometric Turbidity Units
PACl	Poly Aluminium Chloride
Pb	Lead
TUC	Trade Union Congress
V	Vanadium
WQI	Water Quality Index
Zn	Zinc

CHAPTER 1

INTRODUCTION

Over the past decades, rivers have been the centre of life where human came to settle, bringing new life around them. Despite that, as time goes by, systematic pumping and technologies have brought people far from where they began. Previously rivers have been used for cleaning, drinking and hunting but are now the ultimate aim for chemical industrialist to dispose unwanted filthy chemicals including heavy metals. Time has changed many things with technologies blunting awareness in humans. The fast forward phase changes rivers from being the soul of life into just an ultimate receiver.

The water quality in rivers in Malaysia are showing a deteriorating trend as many rivers and coastal areas are reported to be contaminated with heavy metal especially water bodies in industrial areas. Common states with industrial activities in Malaysia include Selangor, Penang and Johor. Each of this state has heavy metal contaminated water bodies. Some of the rivers are Langat River, Selangor, Juru River, Penang and Segget River, Johor (Zainudin, 2010). The mixing of point and nonpoint sources has worsened the condition.

This condition brings researchers to interest in finding cost-effective and greener options as an attempt to solve the problems. Bioremediation offers great potential and efficiency and many studies have been conducted to explore this process especially by using microorganism. Other than that, phytoremediation has received great attention for its potential to treat contaminants including soil and water. Phytoremediation started receiving more attention as some constituent in contaminants such as metal elements cannot easily be treated by microorganism.

There was also a study that used a combination of microorganism and plant (Chibuike *et al.*, 2014).

Phytoremediation is one among many other options that can offer wide range of plants to treat heavy metals in contaminated sites. As this research focuses more on heavy metals in contaminated water, aquatic plants offer suitable and accessible properties as candidates. Three species that were chosen are *Eichhornia crassipes*, *Pistia stratiotes* and *Ipomoea aquatica*. Each of them has their own uniqueness in standing as potential plants for phytoremediation as every species has different types of leaves and roots.

Aquatic plants are divided into four types. This includes emergent macrophytes, floating leaved macrophyte, submerged macrophyte and free-floating macrophyte. *I. aquatica* is categorized under emergent macrophytes; and *E. crassipes* and *P. stratiotes* are categorized under free-floating macrophytes. (Sood *et al.*, 2012) The emergent mecrophyte, *I. aquatica* has elliptic leaves and adventitious roots (Edie and Ho, 1969). *E. crassipes* has thick and rounded leaves and has feathery root. (Prescott, 1969) Meanwhile, *P. stratiotes* has thick hairy leaves and adventitious roots (Odjegba *et al.*, 2004). The unique morphology of each species provides different expectations.

Problem statement

The conditions of rivers in Malaysia, especially in the Selangor area are degrading due to pollutants from poultry farms, plantations, municipal waste waters including industrial wastewaters (Fulazzaky *et al.*, 2010). Malaysian industrial players did not pay much concern in their management of chemical wastes with some even illegally dumping chemicals. The landfills show the presence of heavy metal. A study showed that, there was a heavy metal contamination of Fe, Mn, Cu, Cr, Ni, Zn, Pb and Co in soil beneath the waste disposal site at Dengkil, Selangor (Bahaa-Eldin *et al*., 2008).

There was a report on heavy metal accumulation of Hg, As, Pn and Zn in commercially important fishes in the coast of South West Malaysia (Kamaruzzaman, 2011). Five species (*Nemipterus japonicas*, *Chirocentrus dorab*, *Lutjanus sebae*, *Otolithes ruber* and *Pampus argenteus*) are collected from south western coast covering three states, Johor, Melaka and Negeri Sembilan and accumulation of four heavy metals (Hg, As, Pb and Zn) in gill and muscle tissue of the species had been determined. It was observed that higher heavy metal concentration was detected in gill tissue than the muscle tissue of selected species while Hg concentration was higher in muscle tissue with the exception in *P. argenteus* (Kamaruzzaman, 2011).

Rivers and water bodies especially in industrial areas had been experiencing increasing levels of heavy metal contamination. Port Klang coastal areas have been reported to have significant presence of heavy metals in water and sediments (Sany *et al.*, 2013) as well as Sungai Buloh River with a quite severe concentration of Zn, Cu, Ni and Pb (Nemati *et al*., 2011). This condition increases the concern of clean water availability in the future and heavy metal contaminated water borne diseases. Other than health, this condition also gives rise to the concern of the treatment cost. The financial burden for the treatment cost brought up the idea of phytoremediation. Suitable and potential plant to phytoremediate heavy metals needed to be chosen to screen its ability to treat the heavy metals from water.

Objectives

1. To design a preliminary screening method for phytoremediation using spectrophotometer
2. To identify the presence of increasing or decreasing trend from the data across different concentration of heavy metal treatments.

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