UPTAKE OF HEAVY METALS BY Moringa oleifera PLANTED IN CONTAMINATED SOIL

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UPTAKE OF HEAVY METALS BY *Moringa oleifera* PLANTED IN CONTAMINATED SOIL

By

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A Project Report Submitted in Partial Fulfilment of the Requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry Universiti Putra Malaysia

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DEDICATION

Dedicated to my beloved family and the people who are special to me for supporting and inspiring me during my entire study period.

ABSTRACT

Phytoremediation is the use of plants to remediate pollutants from soils and this approach has not been widely practiced in Malaysia. This study was conducted in a greenhouse, at the Faculty of Forestry, Universiti Putra Malaysia. The objectives of this study were to determine the potential of *Moringa oleifera* in removing heavy metals of contaminated soil and to evaluate the heavy metals uptake and translocate in plant parts especially roots, stems and leaves by using an indicator of Translocation Factor (TF) and Bio-concentration Factor (BCF). *M. oleifera* were germinated at the greenhouse for two months prior transplanting into growth media (soil + heavy metals) for five months. The seedlings were planted on 10 different growth media with replicated for four times (soil + different concentrations of heavy metals) namely; control T_0-Control (100% soil), T_1 (soil 1kg + 100ppm $CuSO_4$), T_2 (soil 1kg + 200ppm $CuSO_4$), T_3 (soil 1kg + 300ppm $CuSO_4$), T_4 (soil 1kg + 100ppm $FeSO_4$), T_5 (soil 1kg + 200ppm $FeSO_4$),T_6 (soil 1kg + 300ppm $FeSO_4$), T_7 (soil 1kg + 100ppm $ZnSO_4$), T_8 (soil 1kg + 200ppm $ZnSO_4$), and T_9 (soil 1kg + 300ppm $ZnSO_4$).The results showed that the concentrations of heavy metals among treatments before planting and after harvesting were significant differences. After harvesting,concentration of Cu, Fe and Zn decreased in all treatments whereaswere very effective in removing the heavy metal which wasin T_9 (3.110 mg kg^{-1}) for Cu, Fe was in T_6 (1046.382mg kg^{-1}) while Zn in T_9(42.777 mg kg^{-1}). Studies showed that, the highest accumulation of Cu in the plant parts was in root of T_3 (1.148mg kg^{-1}) as well as Fe (346.293 mg kg^{-1}) for T_6 and Zn(14.085mg kg^{-1}) in T_9. Bioconcentration Factors (BCF) and Translocation Factor (TF) for the three heavy metals (Cu, Fe and Zn) showed that BCF values were lower than 1, while TF above than 1, indicating that *M. oleifera* is capable to translocate metals from roots to shoots and this study confirms that this species as a phytoextractor plant.

ABSTRAK

Fitoremediasi adalah penggunaan tumbuhan untuk memulihkan pencemar dari tanah dan pendekatan ini tidak diamalkan secara meluas di Malaysia. Kajian ini dijalankan di rumah hijau, di Fakulti Perhutanan, Universiti Putra Malaysia. Objektif kajian ini adalah untuk mengenalpasti kebolehan *Moringa oleifera* dalam penyerapan logam berat tanah yang tercemar dan menilai pengambilan logam berat dan translokasi unsur-unsur logam berat di bahagian tumbuhan terutama akar, batang dan daun dengan menggunakan penunjuk Faktor Translokasi (TF) dan Faktor Biokepekatan (BCF). *M. Oleifera* dicambahkan di rumah hijau selama dua bulan sebelum ditransplantasikan ke dalam media pertumbuhan (tanah + logam berat) selama lima bulan. Anak pokok ditanam di 10 media pertumbuhan yang berbeza dengan direplikasi selama empat kali (tanah + kepekatan logam berat yang berbeza) iaitu; kawalan T_0-Kawalan (100% tanah), T_I (Tanah 1kg + 100ppm $CuSO_4$), T_2 (Tanah 1kg + 200ppm $CuSO_4$), T_3 (Tanah 1kg + 300ppm $CuSO_4$) + 200ppm $FeSO_4$), T_6 (Tanah 1kg + 300ppm $FeSO_4$), T_7 (Tanah 1kg + 100ppm $ZnSO_4$), T_8 (Tanah 1kg + 200ppm $ZnSO_4$) dan T_9 (Tanah 1kg + 300ppm $ZnSO_4$). Hasil kajian menunjukkan terdapat kepekatan logam berat diantara rawatan sebelum penanaman dan selepas penuaian adalah perbezaan yang ketara.Selepas penuaian, kepekatan Cu, Fe dan Zn berkurangan dalam semua rawatan manakala sangat berkesan dalam mengeluarkan logam berat yang terdapat dalam T_9 (3.110 mg kg^{-1}) untuk Cu, Fe pada T_6 (1046.382 mg kg^{-1}) manakala Zn dalam T_9 (42.777 mg kg^{-1}). Kajian menunjukkan bahawa pengumpulan tertinggi Cu pada bahagian tumbuhan adalah akar T_3 (1.148 mg kg^{-1}) serta Fe (346.293 mg kg^{-1}) untuk T_6 dan Zn (14.085 mg kg^{-1}) untuk T_9. Faktor Biokepekatan (BCF) dan Faktor pemindahan (TF) untuk tiga logam berat (Cu, Fe dan Zn) menunjukkan nilai BCF lebih rendah daripada 1, manakala TF di atas daripada 1, menunjukkan bahawa *M. oleifera* mampu mengalihkan logam dari akar untuk pucuk dan kajian ini mengesahkan bahawa spesies ini sebagai tumbuhan fitoektraktor.

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APPROVAL SHEET

I certify that this research project report entitled “Uptake of Heavy Metals by *Moringa oleifera* Planted in Contaminated Soil”by Norsuria Mirza binti Jamalludin has been examined and approved as a partial fulfilment of the requirements for the Degree of Bachelor of Forestry Science in the Faculty of Forestry, Universiti Putra Malaysia,

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LIST OF ABBREVIATIONS

AAS	Atomic Absorption Spectrometer
AA	AutoAnalyzer
ANOVA	Analysis Of Variance
Bf	Bioaccumulation Factor
Ca	Calcium
Cu	Copper
FAO	Food And Agriculture Organization
Fe	Iron
G	Gram
Kg	Kilogram
K	Potassium
M	Meter
Mg	Miligram
Mn	Manganese
N	Sodium
P	Phosphorus
Pb	Lead
Ph	Acidicity In Water
Ppm	Parts Per Million
TF	Translocation Factor
Upm	University Putra Malaysia

CHAPTER 1

INTRODUCTION

1.1 General Background

Today, the development of industrial and agriculture are increasing drastically which contributed to elevated levels of heavy metals in the environment. Although heavy metals are naturally present in the soil, but the activities from industrial and agriculture such as mining, sewage sludge and application of insecticides and fertilizers mostly make the concentration of heavy metal are too high and become toxic. The presence of large amount of heavy metals can negatively affect living organisms in many ways. Plus, heavy metal contamination is considered a serious threat to soil and water resources and subsequently to human health (Yoon *et al.,* 2006). However, at the presence of small amounts of heavy metals can actually be beneficial for humans and plants such as such as Fe, Mn, Zn, Cu and Pb are essential for plant growth (Amadi & Tanee, 2014). Therefore, it is essential to ensure that these heavy metals are being controlled and that they do not negatively affect human food cycle.

Many treatment methods have been purposed as removal of heavy metals. There are many existing method eather in chemical or physical methods including, solidification, stabilization, electrokinetics, vitrification, vapour extraction, and soil washing and flushing. However these methods are costly and do not make the soil suitable for plant growth (Chibuike & Obiora, 2014). Consequently, phytoremediation techniques are frequently listed among the

best option for remediation of heavy metal-contaminated sites (Wuana & Okieimen, 2011). These methods have only been reported in developed countries due to their cost effectiveness and environment friendliness.

Phytoremediation is a one technique to uptake the heavy metal from contaminated soil and it can use to remove the contaminant in environment through plants. The word Phytoremediation come from the Greek word (phyton) combination that refer to preserves. Phytoremediation is process that treating the soil or water resources by using the various of plants that have been polluted by waste products. It is can be divided into five types, phytoextraction, phytostabilization, phytodegradation, phytovolatilization and rhizofitration.

In order to degrade or remediate contaminats from soil, the selection of plants are also important to make sure they can removal some types of heavy metals and organic pollutants which contributed to soil decline in soil quality. The best plants for particular phytoremediation task should be selected based on multiple plants characteristic (Majid *et al.,* 2011). The plants should be fast growing, having of high biomass and natural tolerance to toxic substance such as heavy metal and salinity (Majid *et al.,* 2011). For this study, the plant species *Moringa oleifera* belongs to the monogeneric family Moringaceae, which includes another 12 species of shrubs and trees (Olson 2002; Verdcourt 1985) was selected to determine its potential in removing heavy metals of soil contaminated. This plant is a remarkable species with good biomass production and fast growing species, which can

be used as aphytoremediation.The fast growth and regular harvests lead to rapid uptake of nutrients, and hence also heavy metals, from the soil.

1.2 Problem Statement and Justification

The rapid of activities from industrial and others activities for example mine tailings, application of land fertilizers, manures from animal, uses of pesticides, sewage sludge, resudues of coal combustion, wastewater irrigation, spillage of petrochemicals, and atmospheric deposition are promote soil become contaminated. This is because of the accumulation of heavy metal that produced by the accumulation of heavy metals and metalloids through emissions from those anthropogenic activities. Heavy metals occur naturally in the soil environment but the higher concentration of heavy metal can give toxic to the soil environment. On highly contaminated soils, or on mining wastes, tree establishment may be inhibited by high concentrations of heavy metals (Pulford, 2003).

Pollution by heavy metals and organic contaminants is probably the most serious problem as the contamination is practically irreversible. Contamination by heavy metal can affect human health either through direct contact or by ingestion through the food chain. In addition, the process of removal the heavy metal pollutant is critical because cleaning contaminated soils is extremely expensive and difficult. Hence, an environmental friendly and cost effective method needs to be developed to remove of heavy metal from sewage sludge while maintaining beneficial properties.

However, several of heavy metals actually are necessary for human health, and plants, but only in low level and not be dangerous if they are taken into the body in foods or as supplements at appropriate level. Since some plants species are capable of tolerating and accumulating heavy metals and they can grow successfully in soil amended with heavy metals. Therefore, one of the most suitable technique that can be apply to overcome the problem of heavy metal in soil contaminated is phytoremediation. However, some of tree species are generally not able to adapt to high concentrations of heavy metals in the soil. Only a few tropical tree species have been identified as effective phytoremediators. Therefore, research has demonstrated that plants species are effective in removing heavy metals, resist to highs concentrations of toxic metal. Shrub species are particularly suitable for phytoremediation research due to easy to find, and it is fast growing.

For this, I selected *Moringa oleifera* and tested its potential as phytoextractor, especially based on the following characteristics, fast growing, having of high biomass and natural tolerance to toxic substance such as heavy metal and salinity and easy to cultivate. Studies to determining the potential for plant species to be used as phytoremediator are scarce or even lacking.

1.3 Objective

The main objective of this study is to determine the potential of *Moringa oleifera* in removing heavy metals of soil contaminated. In addition, this study also attempts to evaluate the heavy metals uptake and translocation in plant parts especially roots, stems and leaves by using an indicator of Translocation Factor (TF) and Bio-concentration Factor (BCF).

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