# *PHYTOREMEDIATION OF HEAVY METALS BY MARIPOSA Christia vespertilionis FROM CONTAMINATED SOILS*

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# PHYTOREMEDIATION OF HEAVY METALS BY MARIPOSA *Christia vespertilionis* FROM CONTAMINATED SOILS.

**BY**

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**A Project Report Submitted in Partial Fulfillment 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:

Abdul Razak Bin Abu Bakar

Maharani Binti Hussin

Also my siblings.

To my dear friends:

Norsuria Mirza bin Jamalludin

Nurul Atikah Binti Abu Bakar Hamzah

Nurul Aisyah Binti Mohd Sapri.

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

## ABSTRACT

Phytoremediation is the technique that uses of plants to remediate pollutants from soils and this approach has not been widely practiced in Malaysia. The objectives of this study were: (i) to determine the potential of *Mariposa Christia vespertilionis* in uptaking heavy metal from contaminated soils and (ii) to evaluate the heavy metals uptake and translocation in plant parts such as roots, stems and leaves. The seedlings of *Christia vespertilionis* were planted on ten different treatments with four replicates for each treatment namely; $T_0$ (control), $T_1$ (1 kg soil + 100ppm Cu), $T_2$ (1 kg soil + 200ppmCu), $T_3$ (1 kg soil + 300ppm Cu), $T_4$ (1 kg soil + 100ppm Fe), $T_5$ (1 kg soil + 200ppm Fe), $T_6$ (1 kg soil + 300ppm Fe), $T_7$ (1 kg soil + 100ppm Zn), $T_8$ (1 kg soil + 200ppm Zn), and $T_9$ (1 kg soil + 300ppm Zn). pH both of growth media was determined using galss electrode whereas the concentrations of heavy metals consist of Copper (Cu), Iron (Fe) and Zinc (Zn) in the growth media were analyzed using atomic absorption spectrometer (AAS). The results showed the concentration of heavy metals after harvesting in growth media were highest in Fe concentrations than Zn and Cu, from 1742.23 mg/kg to 696.89 mg/kg in, 71.19 mg/kg to 28.48 mg/kg for Zn in $T_9$, and 5.20 mg/kg to 2.08 mg/kg for Cu in $T_3$. The accumulation of heavy metals in the roots, stems and leaves increased with the increasing of concentrations of heavy metals. The most plant parts that storing Cu and Fe concentrations were roots parts at 0.3 mg/kg and 91.49 mg/kg. Zn concentrations stored most in stems parts at 3.98 mg/kg. *Christia vespertilionis* seems to have high potential to retain high amounts of Cu, Fe and Zn. *Christia vespertilionis* showed TF values were greater than 1 and BCF value was lower than 1 for all concentrations of heavy metals. This indicates that *Christia vespertilionis* has potential as a phytoextractor plant.

## ABSTRAK

Fitoremediasi adalah teknik yang menggunakan tumbuhan untuk memulihkan bahan pencemar dari tanah dan pendekatan ini tidak diamalkan secara meluas di Malaysia. Objektif kajian ini adalah: (i) untuk menentukan potensi Mariposa *Christia vespertilionis* dalam pengambilan logam berat dari tanah yang tercemar dan (ii) untuk menilai pengambilan logam berat dan translokasi di bahagian tumbuhan seperti akar, batang dan daun. Anak-anak pokok *Christia vespertilionis* ditanam pada sepuluh rawatan yang berbeza dengan direplikasikan sebanyak empat kali untuk setiap rawatan iaitu ; $T_0$ (kawalan), $T_1$ (1 kg tanah + 100ppm Cu), $T_2$ (1 kg tanah + 200ppmCu), $T_3$ (1 kg tanah + 300ppm Cu), $T_4$ (1 kg tanah + 100ppm Fe), $T_5$ (1 kg tanah + 200ppm Fe), $T_6$ (1 kg tanah + 300ppm Fe), $T_7$ (1 kg tanah + 100ppm Zn), $T_8$ (1 kg tanah + 200ppm Zn), dan $T_9$ (1 kg tanah + 300ppm Zn). pH kedua-dua media pertumbuhan telah ditentukan dengan menggunakan kaca elektrod manakala kepekatan logam berat terdiri daripada tembaga (Cu), besi (Fe) dan Zink (Zn) dalam media pertumbuhan dianalisis dengan menggunakan spektrometer serapan atom (AAS). Keputusan menunjukkan kepekatan logam berat selepas penuaian dalam media pertumbuhan adalah tertinggi dalam kepekatan Fe daripada Zn dan Cu, daripada 1742.23 mg/kg hingga 696.89 mg/kg dalam $T_6$, 71.19 mg/kg hingga 28.48 mg/kg untuk Zn dalam $T_9$, dan 5.20 mg/kg hingga 2.08 mg/kg untuk Cu dalam $T_3$. Pengumpulan logam berat di akar, batang dan daun meningkat dengan peningkatan kepekatan logam berat. Bahagian paling banyak tumbuhan yang menyimpan kepekatan Cu dan Fe adalah bahagian akar pada 0.3 mg/kg dan 91.49 mg/kg. Kepekatan Zn disimpan paling banyak di bahagian batang pada 3.98 mg/kg. *Christia vespertilionis* nampaknya berpotensi tinggi untuk mengekalkan jumlah tinggi Cu, Fe dan Zn. *Christia vespertilionis* menunjukkan nilai TF lebih besar daripada 1 dan nilai BCF lebih rendah daripada 1 untuk semua kepekatan logam berat. Ini menunjukkan bahawa *Christia vespertilionis* mempunyai potensi sebagai tumbuhan *phytoextractor*.

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## APPROVAL SHEET

I certify that this research project report entitled “Phytoremediation of Heavy Metals by Mariposa *Christia vespertilionis* From Contaminated Soils” by Dewi Kartini Binti Abdul Razak 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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# CHAPTER 1

# INTRODUCTION

## 1.1 General Background

Activities of man, rapid industrialization and urbanization lead to a serious problem that is soil pollution and this is a serious threat to the global environment and human health. Soil health plays an important role in the growth of plants and trees, including maintaining the ecosystem with its natural fauna, flora and indirectly sustains the environment to its natural conditions (Jayanthi *et al*., 2013). However, the quality of soil decreasing by time caused by many factors. This type of contamination typically increases from underground storage links, various application of pesticides, oil and fuel dumping, leaching of wastes from landfills or direct discharged of industrial wastes to the soil (Jayanthi *et al*., 2013).

Soil contamination due to heavy metals arises due to human activities that bring to negative externalities arising from unsustainable industrial and agricultural practices and policy failures and lacking to completely tackle this issue (Sarwar *et al*., 2016). Heavy metals are the most dangerous pollutants because these heavy metals characterized as non-degradable and accumulate then become toxic to plants and animals (Majid *et al.,* 2011). Example of heavy metals are Cu, Fe and Zn. Sometimes these heavy metals are needed in small amounts by plants and animals (Rajoo *et al.,* 2013). However, Rajoo *et al*., (2013) studies that the heavy metal become toxic when they reach high concentration since they are not metabolized and accumulates in the soft tissues. "Over recent

decades, the annual worldwide release of heavy metals reached 939,000 t (metric ton) for copper, 783,000 t for lead and 1,350,000 t for zinc" (Majid *et al*., 2011). Excessive metal accumulation in contaminated soils can result in decreased soil microbial activity, soil fertility, and overall soil quality, and reductions in yield and the entry of toxic materials into the food chain (Purakayastha and Chhonkar, 2010).

Conventional technologies need a large cost for the remediation of heavy metals polluted sites (Pandey, Pandey & Singh, 2015). In the past, chemical pollution in soil has been treated using physical and chemical processes that have proven to be expensive (Majid *et al*., 2011). According to Ali, Khan and Sajad (2013), the physical and chemical methods suffer from limitations like high cost, intensive labour, and irreversible changes in soil properties. The use of physico-chemical approaches for soil recovery leave the ground unusable for the plant growth because this decontamination process eliminates the biological activities of the soils (Leguizamo, Gomez & Sarmiento, 2017).

Therefore, research is needed to come out with the method which is cost effective, efficient and environment friendly remediation methods for decontamination of heavy metal-polluted soils. As mentioned by Sarwar *et al*. (2016) among various physical, chemical and biological techniques, phytoremediation is a good strategy to decontaminate heavy metals from soils and have been proven as an effective and economical technique.

Phytoremediation is an emerging technology that exploits the genetic potential of selected plant species to remove and degrade, wide range of contaminants (Purakayastha & Chhonkar, 2010). Another research from Ali, Khan and Sajad (2013) mentioned the phytoremediation method is novel, cost-effective, efficient, environment and eco-friendly, in situ applicable, and solar-driven remediation strategy. Phytoremediation is defined as the use of various plants in treating soil or water resources that were polluted by waste products, and can be further classified into five types, Phytoextraction, Phytostabilization, Phytodegradation, Phytovolatilization and Rhizofitration.

Most of reviews in the past years focus on the phytoremediation of the metallic pollutants in soil, particularly the area of metal hyperaccumulator. According to Yanqun *et al*. (2005), a hyperaccumulator has been defined as a plant that can accumulate cadmium>100 mg/kg, lead>1000 mg/kg, or zinc>10000 mg/kg in their shoot dry matter, and the metal concentrations in shoots are invariably greater than that in roots, sowing a special ability of the plant to absorb and transport metals and store them in their above-ground part. The hyperaccumulator was characterized at first was members of the Brassicaceae and Fabaceae families. The species *Christia vespertilionis* is one of the species in the family of Fabaceae. This species has the characteristics of fast growing species and have natural tolerance to heavy metals.

## 1.2 Problem Statement

The rapid industrialization and agricultural activities change the natural soil environment cause the soil contaminants with toxic metals. The activity of human lead to increase of concentration of heavy metals from year to year. The accumulation of heavy metal such as Cu, Fe, Mn, Pb and Zn lead to harmful to human health and the environment.

Conventional techniques used by past researchers to remediate contaminant soil is highly cost, intensive labour, and disruptive the environment. Various chemical, physical and biological techniques approaches show that the experiment is also time consuming.

One of the most effective method is phytoremediation. However, not all plants can accumulate or metabolize heavy metals and currently. For this final year project, the species *Christia vespertilionis* was selected regarding the following characteristics in phytoremediation that is fast growing and tolerance to heavy metals.

## 1.3 Objectives

The objectives in this study is to determine the potential of Mariposa *Christia vespertilionis* in uptaking heavy metal from contaminated soils and to evaluate the heavy metals uptake and translocation in plant parts such as roots, stems and leaves.

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