

PHYTOREMEDIATION

Using Plant to Remove Heavy Metal



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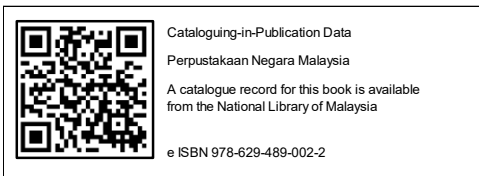
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LIST OF ABBREVIATION

| | |
|-----------------|-------------------------------------------------|
| AAS | Atomic Absorption Spectroscopy |
| ANOVA | Analysis of Variance |
| <i>A. puber</i> | <i>Alocasia puber</i> |
| CCD | Central Composite Design |
| CW | Constructed wetland |
| DOE | Design of Experiment |
| FESEM | Field Scanning Electron Microscope |
| FTIR | Fourier Transform Infrared |
| HRT | Hydraulic retention time |
| HSFCW | Horizontal subsurface flow constructed wetlands |
| TEM | Transmission Electron Microscopy |
| RSM | Response Surface Methodology |
| SFCW | Surface flow constructed wetlands |
| SFCW | Surface flow constructed wetlands |
| SSFCW | Sub-surface flow constructed wetlands |
| TF | Translocation factor |
| VSFCW | Vertical subsurface flow constructed wetlands |

PREFACE

Alhamdulillah, praise to Allah, with all His kindness and mercy, gave us the chance to complete this book. This book was written with the highest quality and the most up-to-date information from the recent research area. Insha'Allah, it can attract the interest of readers from all groups, whether students, industry, or government, via a professional writing style through the description of facts and good discussion. The content in this book is relevant and beneficial for referencing, especially for individuals who work directly in the wastewater treatment area. Hopefully, with some effort in sharing expertise and information, it can be utilised as a guide for people interested in utilising technology to its greatest potential.

We want to take this opportunity to express our deepest appreciation and gratitude to everyone who contributed to the successful completion of this book. We appreciate your guidance, providing a meaningful suggestion, and transforming this book into one of the most precious items. Also, not to be forgotten is Assoc. Prof. Dr Zulhazman Hamzah introduced the *Alocasia puber* and contributed to the interesting photos of the plant. Additionally, with the help of the expert, Dr. Halim Hj. Razali (SERI, UKM), through his theoretical approach HRST (Halim Razali Strategic Theory), effectively processed and transformed this original work into a scholarly book of the highest quality that fulfils the publication criteria of UMK Press and Myra. Special thanks to Dr. Ikarastika Rahayu Abdul Wahab, Dr. Nik Raihan Nik Yusoff, and Assoc. Prof. Dr. Zainul Akmar Zakaria for their comprehensive review and proofreading of the content in this book.

The book is divided into seven chapters that explore various aspects of heavy metal removal using plants. Chapter 1 introduces

the manufacturing industry, which, if managed effectively, can have a positive impact on the environment. Next, chapter 2 discusses water pollution caused by heavy metals. Additionally, the source, properties, and toxic effects of heavy metals were addressed. Several conventional remediation approaches for removing heavy metals are discussed at the end of the chapter. Chapter 3 describes phytoremediation as a method of water treatment. A list of phytoremediation strategies was provided, along with their function and target pollutants.

Furthermore, a constructed wetland for the treatment of water contaminated with heavy metals was discussed. Chapter 4 discusses the removal of heavy metals in a constructed wetland microcosm. The performance of Ni removal using *Alocasia puber* was analysed and predicted. Moreover, the heavy metal content in plant tissue was assessed. Chapter 5 explains *Alocasia puber* as a phytoremediation plant. Several instruments were used to prove *Alocasia puber's* ability to remediate heavy metals. Chapter 6 details the process of establishing a constructed wetland system for phytoremediation. Lastly, chapter 7 summarises the process of phytoremediation's challenges and prospects.

Reading, research, and curiosity towards science will be the keys to the future success of newly established technologies. In addition, all material and technical facts in this book are an extension of the research grant FRGS/1/2016/WAB05/UMK/02/4 or R/FRGS/08.00/00266A/001/2016/000372.

We would also like to express our gratitude to our beloved family for their continuous encouragement and support in producing this book. Not to be forgotten is UMK Publishers, who published this book as part of the nation's scientific treasures.

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CHAPTER 1

HEAVY METALS POLLUTION

INTRODUCTION

Water is a resource that people use every day for things like drinking, cooking, and washing clothes. The agricultural and industrial sectors depend on clean water to operate. Clean and safe water is defined by the United States Geological Survey (USGS, 2008) as “water that will not harm you if you come into contact with it.” Whether it is utilised for drinking, residential use, food production, or recreational activities, having access to safe and readily available water is crucial for maintaining public health. Better water supply, sanitation, and water resource management can improve a nation’s economy and substantially reduce poverty. However, man-made activities that pollute the main water sources are to blame for the ongoing deterioration in water quality. Human activities like illegal logging and the unchecked release of harmful chemicals into rivers have made river water no longer safe to use in homes.

Manufacturing and development activities are known to be harmful to humans and the environment. One of the major concerns would be heavy metal contamination. Heavy metal contamination, commonly found in water, can cause adverse effects on living things (Mishra et al., 2019). Heavy metals exist naturally and are non-biodegradable (Abdel-Rahman, 2022). Studies have shown that high contamination of heavy metals could cause permanent intellectual and developmental disabilities in affected individuals (Balali-Mood et al., 2021). Once heavy metals interact with the natural ecosystem, their metal ions can accumulate in human bodies via direct consumption or throughout the food chain (Upadhyay, 2022).