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Glycine max AS A POTENTIAL PHENOL PHYTOREMEDIATOR

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SOYBEAN *(Glycine max)* AS A POTENTIAL PHENOL PHYTOREMEDIATOR

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LETTER OF CONFIRMATION

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ABSTRACT

There are many reported cases of phenol contamination worldwide. Malaysia itself is also facing the phenol pollution problems. *Glycine max* from the family Leguminocae and is commonly known as soybean is one of the potential plants that can be used to remediate phenol contaminated areas. The aims of this study were to analyse the potential of *G. max* in absorbing phenol from phenol- spiked water and to assess the shoots, roots and leaves growth of *G. max* grown in water spiked with different phenol concentrations. The soybean seeds were germinated and grown in designed system for each respective concentration for six days at room temperature. During the growth period, the elongation of roots, stems and leaves of the soybean plants were measured for every 24 hours by using a standard ruler. The plant morphologies throughout the 6 days were observed. One ml of water sample was collected and subjected to the phenol assay to quantify any remaining phenol in the water. The roots of plants grown in 0.04 g/ L phenol- spiked water were the longest averaging about 17.22 ± 1.23cm. The stem length in 0.04 g/ L phenol was the longest measuring 8.87 ± 0.73 cm. The Control plants exhibited the longest leaves length (1.33 ± 0.60 cm) and the least (0.78± 0.17 cm) was in 0.05 g/ L phenol. No leaves formation could be observed in 0.4 g/ L phenol- spiked water. Phenol at 0.4 g/ L was concluded as high and toxic to the plants since their growths were distorted as early as Day 1. The seeds germinated normally in 0.01, 0.04 and 0.05 g/ L phenol water. Abnormal growth of the plants could be noted at three respective phenol water concentrations which were 0.1, 0.2 and 0.4 g/ L. Plants absorbed 100% phenol at different rates except for 0.04 g/ L, only half (0.20 g/ L) of the phenol was successfully absorbed by the plants on Day 3. The fastest absorption was detected at 0.2 g/ L whereby the plants absorbed all the phenols within 5 days at a rate of 0.00170 g/ L/ hour meanwhile, the slowest rate was at 0.01 g/ L. *G. max* was classified as a phytodegrader in group of phytoremediator since the phenol content in plant tissues after being treated with phenols showed reduction in amount.

ABSTRAK

Terdapat banyak kes pencemaran fenol yang berlaku di seluruh dunia. Malaysia juga turut menghadapi masalah yang sama. Glycine max daripada keluarga Leguminosae yang dikenali sebagai kacang soya adalah salah satu tumbuhan yang mempunyai potensi untuk digunakan bagi merawat fenol di kawasan yang tercemar. Tujuan kajian ini dilakukan adalah untuk menganalisis potensi G. max dalam penyerapan fenol dari air di samping mengukur dan menilai pertumbuhan pucuk, akar dan daunnya dalam kepekatan fenol yang berlainan. Benih kacang soya dibiarkan bercambah terlebih dahulu sebelum diletakkan ke dalam sistem hidroponik yang telah dicipta. Kajian dijalankan pada suhu bilik selama enam hari bagi setiap kepekatan. Dalam tempoh pertumbuhan, pemanjangan akar, batang dan daun pokok telah diukur bagi setiap 24 jam dengan menggunakan pembaris yang sama. Morfologi tumbuhan sepanjang 6 hari diperhatikan untuk mengenalpasti pertumbuhan yang normal dan tidak normal. Satu ml sampel air telah diambil dan esei fenol telah dijalankan untuk mengira fenol yang tertinggal di dalam air. Purata akar pokok yang ditanam dalam 0.04 g / L air mengandungi fenol adalah paling panjang iaitu 17.22 ± 1.23cm. Panjang batang dalam 0.04 g / L fenol juga adalah terpanjang iaitu berukuran 8.87 ± 0.73 cm. Pokok Kawalan menghasilkan daun paling panjang (1.33 ± 0.60 cm) manakala daun yang terpendek adalah yang didedahkankan dalam 0.05 g/ L fenol (0.78 ± 0.17 cm). Tiada pertumbuhan daun yang boleh diperhatikan dalam air yang mengandungi 0.4 g / L fenol. Kepekatan fenol 0.4 g / L disimpulkan sebagai tinggi dan toksik kepada pokok mulai terbantut seawal hari pertama. Benih bercambah secara normal dalam 0.01, 0.04 dan 0.05 g / L air mengandungi fenol. Pertumbuhan abnormal tumbuh-tumbuhan boleh diperhatikan dalam tiga kepekatan air fenol iaitu masing- masing merupakan 0.1, 0.2 dan 0.4 g / L. Pokok menyerap 100% fenol pada kadar yang berbeza kecuali 0.04 g / L, hanya separuh (0.20 g / L) fenol yang berjaya diserap oleh tumbuh-tumbuhan pada hari 3. Penyerapan paling cepat dikesan pada 0.2 g / L fenol di mana pokok menyerap semua fenol dalam masa 5 hari pada kadar 0.00170 g / L / jam. Sementara itu, kadar paling perlahan adalah pada 0.01 g / L. G max diklasifikasikan sebagai tumbuhan degradasi iaitu tergolong dalam tumbuhan remediasi kerana kandungan fenol dalam tisu pokok selepas dirawat dengan air mengandungi fenol menunjukkan pengurangan daripada jumlah asal.

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LIST OF ABBREVIATIONS

Symbol	Definition
%	Percentage
µl	Microlitre
AAP	Aminoantipyrene
Acetyl-CoA	Acetyl Coenzyme A
BOD	Biological Oxygen Demand
Co	Cobalt
Cu	Copper
DNA	Deoxyribonucleic Acid
EPA	Environmental Protection Agency
FAO	UN Food and Agricultural Organization
g	Gram
G. max	*Glycine max*
g/ cm^3	Gram per Cubic Centimetre
g/ L	Gram per Litre
g/ mol	Gram per mol
hPA	Hectopascal
IAA	Auxin
IWK	Indah Water Konsortium
L	Litre
LDL	Lipoprotein
Log K_{ow}	Log Octanol-Water Partition Coefficient
mg/ L	Miligram per Litre
Mo	Molybdenum

Ni	Nickel
ºC	Degree Celcius
PAH	Polycyclic Aromatic Hydrocarbon
Pb	Lead
PCP	Pentachlorophenol
pKa	Negative base-10 logarithm of the acid dissociation constant of a solution
ppb	Part per Billion
ppm	Part per Million
S. acuta	*Sida acuta*
SBP	Soybean Peroxidase
TCA	Tricarboxylic Acid Cycle
TCE	Trichloroethylene
WHO	World Health Organization
Zn	Zinc

CHAPTER 1

INTRODUCTION

Water is a basic necessity for the existence of all living things. It plays a crucial role in the survival rate of living things. It carries a high risk to humans, animals and plants because water is a vehicle for transmittable diseases caused by microorganisms, or by chemicals released by human activities. One cause of water pollution is phenol.

Phenol is one of the pollutants produced by burning wood and petroleum fuel facilities. The presence of phenol in the environment is from a few sources such as refineries, wood reservation plants and multiple chemical industries (Paula and Young, 1998). Mostly, phenol originated from both industrial and natural activities and natural occurrence (Nair et al., 2007). People living near rivers contaminated with phenol often face detrimental health problems. Various traditional techniques such as thermal, physical and chemical had been used to treat the contaminants. However, the techniques used have many bad effects and need high maintenance cost (Lundstedt, 2003). Therefore, a few methods were proposed to treat the phenol pollutions.

Remediation is a process of waste and pollutants management by using organisms to break down contaminants through their natural activity (Merkl, 2005). It has been proven effective for a variety of contaminants such as heavy metals, radio nuclei and a wide range of organic pollutants (Schroder et al., 2002; Schnoor, 2002). Phytoremediation is pollutants biodegradation process by using plant. Plants may also contribute to changes in soil structure that benefit microbial degradation of pollutants (Angers and Caron, 1998). Phytoremediation is a developing technology, which has most commonly been associated with inorganic compounds such as heavy metals (Meagher, 2000; Wong, 2003). More recently there have been several published studies on the use of phytoremediation to degrade hydrocarbon compounds, including recalcitrant compounds such as PAH (Lee et al., 2008; Palmroth et al., 2002). Morever, phytroremediation which is an effective and economical way of treating recalcitrant contaminants also might be used to treat phenol (Trapp and Karlson, 2001).

Glycine max from the family Leguminocae and is commonly known as soybean is one of the potential plants that can be used to remediate phenol contaminated areas (Mcgrath and Zhao, 2003). Therefore, the potential of soybean to remediate phenol led to this study which was hypothesized that *G. max* was able to absorb and utilize phenol as nutrients for growth thus removing phenol in wastewater. This is suitable with nowadays critical issue where everyone is trying to find the solution regarding phenol pollution.

The objectives of this study were to analyse the potential of *G. max* in absorbing phenol from phenol- spiked water and to assess the shoots, roots and leaves growth of *G. max* grown in water spiked with different phenol concentrations

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