

PERFORMANCE OF WATER HYACINTH  
(*EICHHORNIA CRASSIPES*) IN PALM OIL MILL  
EFFLUENT (POME) TREATMENT

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## **SUPERVISOR'S DECLARATION**

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the Bachelor Degree in Civil Engineering.

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## **STUDENT'S DECLARATION**

I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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## ABSTRAK

Sisa buangan dari tempat-tempat perindustrian sangat rumit dan menyebabkan pencemaran air jika tidak dilepaskan, terutamanya disebabkan oleh pembebanan organik yang tinggi. Efluen kilang minyak kelapa sawit (POME) adalah cecair kecoklatan yang mengandungi jumlah permintaan oksigen biokimia (BOD), permintaan oksigen kimia (COD) dan parameter lain yang dihasilkan dari tanaman pemrosesan minyak kelapa sawit. Oleh itu, rawatan air sisa seperti phytoremediation diperlukan untuk mengurangkan kesan pencemaran. Phytoremediation adalah proses menggunakan tumbuhan akuatik untuk pencemaran dan pengurusan sisa. Objektif penyelidikan ini adalah untuk menyiasat ciri-ciri Kilang Kelapa Sawit Palm (POME) untuk maklumat asas dan untuk mengurangkan bahan pencemar sisa menggunakan *Eichhornia Crassipes* sebelum melaksanakan ke alam sekitar. Kebimbangan parameter adalah permintaan oksigen biokimia, permintaan oksigen kimia, ammonia-nitrogen (NH<sub>3</sub>-N), jumlah pepejal terampai (TSS), kekeruhan, pH, oksigen terlarut (DO), kadmium (Cd), plumbum (Pb) dan tembaga (Cu). Eksperimen ini dijalankan dengan tiga sampel kepekatan yang berbeza iaitu 30%, 20% dan 10% kepekatan. Tumbuhan akuatik dipelihara dalam air suling selama seminggu sebelum memasukkannya ke dalam setiap kepekatan. Eksperimen ini dijalankan selama tiga minggu selepas meletakkan tumbuhan ke dalam setiap kepekatan dan hasil semua parameter diambil dan diukur sekali seminggu untuk setiap kepekatan. Selepas 3 minggu, 72.31%, 73.23% dan 82.85% COD telah dialihkan dari 30%, 20% dan 10% kepekatan sampel, manakala 70.18%, 75.16% dan 80.88% untuk BOD telah dikeluarkan dari 30%, 20% dan 10% kepekatan sampel. Kemudian, penyingkiran untuk NH<sub>3</sub>-N adalah 69.60%, 72.38% dan 77.01% daripada 30%, 20% dan 10% kepekatan sampel, manakala untuk penyingkiran TSS adalah 68.39%, 73.53% dan 78.91% daripada 30%, 20% 10% kepekatan sampel. Peratusan kecekapan penyingkiran kekeruhan adalah 65.63%, 68.18% dan 72.73% daripada 30%, 20% dan 10% kepekatan sampel. Bagi logam berat, penyingkiran Cd dari 30%, 20% dan 10% kepekatan sampel masing-masing adalah 76.02%, 80% dan 87.56%, manakala penyingkiran Cu dari 30%, 20% dan 10% kepekatan sampel adalah 67.55% 69.18% dan 72.11% masing-masing. Seterusnya, penyingkiran Pb adalah 75.58%, 77.94% dan 79.63% daripada 30%, 20% dan 10% daripada kepekatan sampel. Tetapi nilai untuk pH dan DO adalah nilai negatif yang bermaksud nilai meningkat minggu demi minggu. Selepas minggu ke-3, peningkatan kecekapan pH adalah 23.73%, 24.59% dan 25.40% daripada 30%, 20% dan 10% kepekatan sampel manakala 64.00%, 65.00% dan 85.71% DO telah meningkat dari 30%, 20% 10% kepekatan sampel masing-masing. Sebagai kesimpulan, proses phytoremediation boleh digunakan sebagai rawatan sisa perindustrian dan *Eichhornia Crassipes* juga memberi kecekapan tinggi dalam mengeluarkan bahan cemar dalam kepekatan 10% efluen kilang minyak sawit.

## ABSTRACT

Wastewaters from industrial places are very complex and lead to water pollution if discharge untreated, especially due to its high organic loading. Palm oil mill effluent (POME) is a brownish liquid that contains high amount of biochemical oxygen demand (BOD), chemical oxygen demand (COD) and other parameters have been produced from the palm oil processing plants. Therefore, wastewater treatment such as phytoremediation is needed to decrease the effect of contamination. Phytoremediation is a process using aquatic plants for pollution and waste management. The objectives of this research were to investigate the characteristics of Palm Oil Mill Effluent (POME) for baseline information and to reduce the waste contaminants using *Eichhornia Crassipes* before discharging to the environment. Parameter concerns were biochemical oxygen demand, chemical oxygen demand, ammonia-nitrogen (NH<sub>3</sub>-N), total suspended solids (TSS), turbidity, pH, dissolved oxygen (DO), cadmium (Cd), lead (Pb) and copper (Cu). This experiment was conducted with three different concentrations of sample which were 30%, 20% and 10% concentration. The aquatic plant was preserved in distilled water for a week before putting them into each of the concentrations. This experiment was conducted for three weeks after putting the plant into each concentration and the result of all parameters were taken and measured once a week for each concentration. After week 3, 72.31%, 73.23% and 82.85% of COD had been removed from 30%, 20% and 10% of sample concentration, while 70.18%, 75.16% and 80.88% for BOD had been removed from 30%, 20% and 10% of sample concentration. Then, the removal for NH<sub>3</sub>-N were 69.60%, 72.38% and 77.01% from 30%, 20% and 10% of sample concentration, whereas for TSS removal were 68.39%, 73.53% and 78.91% from 30%, 20% and 10% of sample concentration. The percentage of turbidity removal efficiency were 65.63%, 68.18% and 72.73% from 30%, 20% and 10% of sample concentration. For heavy metal, the Cd removal from 30%, 20% and 10% of sample concentration were 76.02%, 80% and 87.56% respectively, while the Cu removal from 30%, 20% and 10% of sample concentration were 67.55%, 69.18% and 72.11% respectively. Next, the Pb removal were 75.58%, 77.94% and 79.63% from 30%, 20% and 10% of sample concentration respectively. But the value for pH and DO were negative value which means the values were increased week by week. After week 3, the pH increasing efficiency was 23.73%, 24.59% and 25.40% from 30%, 20% and 10% of sample concentration while 64.00%, 65.00% and 85.71% of DO had been increased from 30%, 20% and 10% of sample concentration respectively. As a conclusion, phytoremediation process can be used as an industrial waste treatment and *Eichhornia Crassipes* also give high efficiency in removing contaminant in 10% concentration of palm oil mill effluent.

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## LIST OF SYMBOLS

mg/L	Milligram per litre
$\mu\text{S/cm}$	MicroSiemens per centimetre
$^{\circ}\text{C}$	Degree Celsius
%	Percent
=	Equal
>>	Greater than

## LIST OF ABBREVIATIONS

AAS	Atomic Absorption Spectrophotometry
BOD	Biochemical Oxygen Demand
Cd	Cadmium
CDOM	Coloured Dissolved Organic Matter
COD	Chemical Oxygen Demand
Cu	Copper
DO	Dissolved Oxygen
DOE	Department of Environment
FAAS	Flame Atomic Absorption Spectrophotometry
FDOM	Fluorescent Dissolved Organic Matter
NH <sub>3</sub> -N	Ammonia-Nitrogen
JTU	Jackson Turbidity Unit
NTU	Nephelometric Turbidity Unit
Pb	Lead
POME	Palm Oil Mill Effluent
TSS	Total Suspended Solid



## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of Study

Phytoremediation is a technology or method that uses living plant to clean soil, water and air that contaminated with hazardous contaminants. Recently, phytoremediation has been acknowledged as a novel technology for efficient wastewater treatment which is well accepted by the people, for the reason that it is ecofriendly and cost-effective (Anning et al., 2013). In my study, I used aquatic plants in order to clean and improve the quality of Palm Oil Mill Effluent (POME). Palm oil has become a global agricultural commodity, major and commonly used for food or non-food applications. In addition, palm oil also has been touted as promising feedstock for biofuel production and some of the country had applied it in their daily life such as cooking oils and constituent of margarine.

Palm oil mill wastewater is different from Palm Oil Mill Effluent (POME). Effluent water is defined as water discharge from industry, which contains soluble materials that are injuries to the environment. This wastewater cannot be disposed of as such by inland or subsurface disposal methods as it will contaminate fresh water resources resulting in ecological imbalance and water pollution hazards (Bande et al., 2008). Releasing POME without sufficient treatment into aquatic environments can increase both biological oxygen demand and chemical oxygen demand (Kamyab et al., 2015). Besides, the palm oil mill wastewater is obtained after the treatment of Palm Oil Mill Effluent (POME). Palm Oil Mill Effluent (POME) is more polluted compared to palm oil mill wastewater because it acidic and has a very high biochemical oxygen demand (BOD). There are several stages of processing the extraction of palm oil from the fresh fruit brunches (FFB). These include sterilization, bunch stripping, digestion, oil extraction and finally clarification and purifications; each process with its own

various operations. These extraction and purification processes generate different kinds of waste.

Currently, effluent have been discharged from palm oil mill, which have a high concentration of organic contents is dumped into open lagoons for anaerobic treatment. Even though the effluent has been treated which called wastewater, it still has the hazardous contaminant but in small quantity. The treatment of Palm Oil Mill Effluent (POME) is used in order to make sure that the wastewater that have been discharge to the river meets the requirement of the Department of Environmental (DOE). Besides, to make the water more acceptable for a desired end use, including as drinking water, industrial processes, medical and many other uses. The applications of treatment technologies such as iotation, coagulation, flocculation, activated sludge, etc. in wastewater remediation have been documented extensively in the literature (Akpor and Muchie, 2010). The study aims to investigate the characteristics of Palm Oil Mill Effluent (POME) for baseline information and to reduce the waste contaminants using *Eichhornia Crassipes* before discharging to the environment.

## **1.2 Problem Statement**

Nowadays, Malaysia has faced environmental pollution, which have a long history and becoming serious since last the last decade due to the economic development and increased in industrial activities. There are several types of pollution which are water pollution, noise pollution, air pollution, soil pollution and others which they may come from different sources and have different consequences. In Malaysia, the most environmental issue is water pollution. Water pollution involves such as any whether from chemical, contaminated water, particulate or bacterial matter that degrades the quality and purity of the water. Water pollution can occur in lakes, and underground reservoirs oceans, and as different water sources flow together through the water cycle the pollution can spread (Mayntz, 2018).

There are two sources of water pollution in Malaysia which are domestic sewage and industrial waste. From the previous research, industrial waste has higher pollutant than domestic sewage. Most of industries use chemical processes in order to avoid environmental degradation and threats to human health. However, subsequent utilization of such facilities has disadvantages, particularly when considering economical aspects (Hadiyanto et al., 2014). In industrial wastewater treatment, the

most common and efficient system applied in the industry by the palm industry are ponding system, the open tank digester, close tank digester, thermophilic anaerobic contact process and extended aeration. Although the palm oil industry has applied biological treatment for POME, it still faces challenges or balancing the environmental protection, its economy, its economic viability and sustainable development.

In this research, an alternative treatment was suggested by using an aquatic plant which is *Eichhornia Crassipes* to treating the contaminants in Palm Oil Mill Effluent (POME). This method of treatment is cost effective compared to chemical treatment system, low maintenance requirements and operational cost also environmental friendly. Although the water is treated first before being discharged for human consumption, to remove the metals to meet the recommended level using the current traditional methods is quite challenging (Awang et al., 2015). In addition, it may reduce the aquatic toxicity in order to improve the water quality and finally industrial effluent discharge standard requirement can be achieved.

### **1.3 Objectives**

There are two main objectives of this research study. The objectives are:

- i) To investigate the characteristics of Palm Oil Mill Effluent (POME) for baseline information.
- ii) To reduce the waste contaminants using *Eichhornia Crassipes* before discharging to the environment.

### **1.4 Scope of Study**

This study was conducted as a preliminary study to treat the palm oil mill effluent at Gambang, Pahang. The sample was taken from Kilang Sawit Dominion Square, Gambang, Pahang. This study covered all activities involved in investigating the characteristics of Palm Oil Mill Effluent (POME) for baseline information and in reducing the waste contaminants using *Eichhornia Crassipes* before discharging to the environment. The experiment was conducted at Faculty of Civil Engineering and Earth Resources, Environmental Laboratory, Universiti Malaysia Pahang (UMP).

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