WATERING OF LANDSCAPE PLANTS USING WASTEWATER TREATED WITH *TERMINALIA CATAPPA*

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"To my loves family....."

Mama, Ablong, Kak Aitul, Abngah, Jiejah,

Farah and Fathin...

Thanks for your support,

To my loves one, thanks for your love, care

and encouragement....

All friends.....

Thank you for everything.....

Our Loves Never Ends

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"In the name of God, the most gracious, the most compassionate"

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ABSTRACT

This study was conducted to identify the antibacterial properties of *Terminalia cattapa* (*TC*) leaves and also to explore the feasibility of using it with domestic wastewater effluent for reuse purposes. Previous study conducted in UTM have shown the potential of using domestic wastewater in watering landscape plants where chlorine was use to disinfect the wastewater. Since chlorine application produce residual effect, *TC* leaves offers another potential to be applied together with the domestic wastewater in order to eliminate bacterial contamination. From analysis conducted, *TC* leaves in blended form with wastewater yield better results compared to cut and original leave form. In this study, effluent from domestic wastewater oxidation pond was collected and applied daily to two landscape gardens with a surface area of 1.5 m x 1.0 m x 0.3 m where both plots were planted with five different plants. The difference between the two plots are one is applied with wastewater and *TC* leaves meanwhile the other one is applied with wastewater only and stand as a control. Wastewater effluents collected were analysed for BOD, COD, *E. coli*, phosphorus, ammoniacal nitrogen and pH. From the result obtained all samples treated using *TC* leaves shows 98% removal of *E. coli* numbers after 5 days treatment. In order to compare bacterial removal, analysis on residual chlorine was also carried out, result obtained shows that even though chlorine is effective in eliminating bacteria it has residue effect which is harmful to human or plants and insects. Treated sewage effluent applied to landscape plants produce better growth when compared to untreated wastewater. The results obtained showed positive growth increment for wastewater with *TC* leaves in terms of height and width for all plants except for *Elephantopus scaber (Es)* which thrive more when applied with wastewater.

ABSTRAK

Kajian ini dijalankan adalah untuk mengenalpasti sifat anti-bakteria dan juga untuk mengkaji kebolehgunaan daun ketapang dalam merawat air sisa domestik untuk tujuan guna semula. Hasil kajian lepas yang dijalankan di UTM, menunjukkan penggunaan air sisa domestik berpontensi digunakan semula untuk menyiram tumbuhan landskap. Dalam rawatan tersebut, klorin telah digunakan untuk merawat air sisa tersebut serta bertindak sebagai agen anti-bakteria. Oleh kerana penggunaan klorin meninggalkan sisa, *TC* menunjukkan potensi untuk digunakan dalam merawat air sisa domestik. Daripada analisis yang dijalankan, daun ketapang yang dikisar dengan air sisa menunjukkan keputusan jauh lebih baik berbanding dengan daun yang dipotong atau dalam keadaan biasa. Dalam kajian ini, efluen dari kolam pengoksidaan telah digunakan dua kali sehari pada dua taman landskap yang berbeza dengan lima jenis tumbuhan di tanam di atas landskap bersaiz 1.5 m x 1.0 m x 0.3 m. Perbezaan antara plot tanaman tersebut ialah satu akan disiram air sisa domestik yang di rawat dengan daun ketapang dan yang satu lagi bertindak sebagai kawalan dan disiram dengan air sisa domestik sahaja. Air sisa domestik yang diambil telah di analisis untuk parameter BOD, COD, *E. coli*, fosforus, ammonia nitrogen dan pH. Dari keputusan yang diperolehi, semua sampel yang dirawat dengan daun ketapang menunjukkan penurunan *E. coli* sebanyak 98% selepas 5 hari. Dalam perbandingan penyingkiran bakteria, analisis terhadap sisa klorin turut di jalankan dan hasil menunjukkan walaupun klorin berkesan untuk membunuh bakteria, ia meninggalkan kesan sisa yang boleh membahayakan manusia, tumbuhan dan juga serangga. Air sisa domestik yang dirawat dan diaplikasikan ke tanaman landskap menghasilkan pertumbuhan baik berbanding dengan air sisa yang tidak dirawat. Keputusan menunjukkan pertumbuhan positif berlaku dalam pertumbuhan tinggi dan lebar daun untuk semua tanaman kecuali pada elephantopus scaber (Es), yang tumbuh subur dengan air sisa domestik yang tidak di rawat.

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^{o}C	degree celcius
BOD	biochemical oxygen demand
COD	chemical oxygen demand
DO	dissolved oxygen
DOE	Department of Environment
GHG	greenhouse gases
GWP	global warming potential
IPCC	Intergovernmental Panel on Climate Changes
m	meter
mg/L	miligram per litre
OP	oxidation pond
SS	suspended solids
TC	*Terminalia catappa*
UTM	Universiti Teknologi Malaysia

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CHAPTER 1

INTRODUCTION

1.1 Introduction

Water is a common substance that is essential for the survival of all known forms of life. In typical usage, water refers only to its liquid form or state, but the substance also has a solid state, ice, and a gaseous state, water vapor or steam (Metcalf and Eddy, 2004). Water covers 71% of the Earth's surface, it is found mostly in oceans and other large water bodies, with 1.6% of water underground in aquifers and 0.001% in the air as vapor, clouds (formed of solid and liquid water particles suspended in air), and precipitation (Marks, 2001). Water is a tasteless, odorless liquid at standard temperature and pressure. The color of water and ice is, intrinsically, a very light blue hue, although water appears colorless in small quantities. Ice also appears colorless, and water vapor is clearly invisible as a gas (Environmental Protection Agency, 2006).

According to Malaysia Water Industry Guide (2007), the increased demand for clean water has led to competition in water use among the various water user sectors and the continued economic growth will magnify this even more acutely. The

practicable limit of surface water resources development has been reached in regions of high demand, and it has become necessary to consider interbasin and interstate water transfers. The current approaches towards water supply in cities are supply driven when there's a "shortage", new sources are developed.

Fresh water is vital to sustain human life. However, only 3% of total water on earth is fresh water and two-thirds of that is in frozen forms such as the polar ice caps, glaciers and icebergs. The remaining 1% of the total fresh water is either surface water or groundwater where groundwater consists of two-thirds of this amount. The United States annually receives rainfall in a quantity sufficient to cover the entire country to a depth of 30 inches that is known as the U.S. water budget (Environmental Protection Agency, 2006). However, the annual precipitation is not evenly distributed around the country. The eastern half of the country receives more precipitation than the western half.

Water is the earth's most ubiquitous and most effective dissolving agent, playing a key role in human civilization. It quenches the thirst and enables the growth of food and fibre for 6.1 billion human inhabitants. Humans now use half of the readily available freshwater, which is in short supply, less than 1% of earth's water resources goes for domestic, agricultural, horticultural, and industrial needs.

The world population in 2008 was estimated at 7.7 billion with an annual growth rate of 3.5 percent or 83 million people per year. To put the recent growth in perspective, the world population in the year 1900 was only 1.6 billion and in 1950 it was 2.5 billion. It is projected that the world population in 2050 will be between 7.9 billion and 10.3 billion (United Nations, 2008). The rate of growth in industrialized countries is well under one percent per year. In developing countries, the growth rate exceeds six percent per year, and in some parts of Malaysia, China andSingapore which the growth rate increase 6.3 percent in 2008 for Malaysia. As a result, over 90 percent of all future population increses will occur in the developing world (United Nations, 2008).

1.2 Problem Statement

The water demands are increasing due to the increasing population and the rapid development in our country (Blumenthal *et al.*, 2000). Devamany a/l S. Krishnasamy (Utusan Malaysia 30 Mac 2005), reported that 12.5-14 billion meter cubic water is used by the humans in the world every year and the usage for a year are 9000 meter cubic per capita global. Increase in population, rapid industrialization and agricultural activities have increased the water demand to a greater extent.

In 2006, the Department of Environment (DOE) registered 18,956 water pollution point sources comprising mainly sewage treatment plants (9,060: 47.79% inclusive of 601 Network Pump Stations), manufacturing industries (8,543: 45.07%), animal farms (869: 4.58%) and agro-based industries (484: 2.55%) represents the distribution of industrial water pollution sources from agro-based and manufacturing industries compiled by the DOE in 2006 through field surveys and questionnaires. A total of 9,027 sources were identified with Selangor having the highest number of water pollution sources (1,850: 20.49%), followed by Johor (1,774: 19.65%).

According to statistics compiled by the Veterinary Department of Malaysia, the total standing pig population for 2006 was about 1.67 million, a decrease of 1.76 percent compared to 1.7 million in 2005. Correspondingly, the number of pig farms decreased to 869 farms compared to 898 in the previous year. The number of sewage treatment plants under the management of Indah Water Consortium Sdn. Bhd. (IWK) had increased to 9,060 in 2006 compared to 8,782 plants in 2005. Selangor had the largest number of sewage treatment plants (2,563: 28.3%), Perak (1,343: 14.8%), Johor (1,010: 11.1%) and Negeri Sembilan (928: 10.2%)

Although the effluents from the sewerage treatment plant are treated, the effluents affect the water pollution in our country particularly when the effluents are

discharged to the river, lake or stream (DOE, 2008). High nutrient concentration in the effluent can contribute to water pollution which can destroy the aquatic life and environment. Therefore, nowadays there are a lot of water pollution issues everywhere around the world.

Water pollution occurs when a body of water is adversely affected due to the addition of large amounts of materials to the water (Metcalf and Eddy, 2004). When it is unfit for its intended use, water is considered polluted. Figure 1.1 below shows the percentage of the activity that contribute to water pollution, and the higher percentages are from sewerage treatment plant compared to other activity. Therefore, an alternative water conversation method needs to be carry out to prevent the problem.

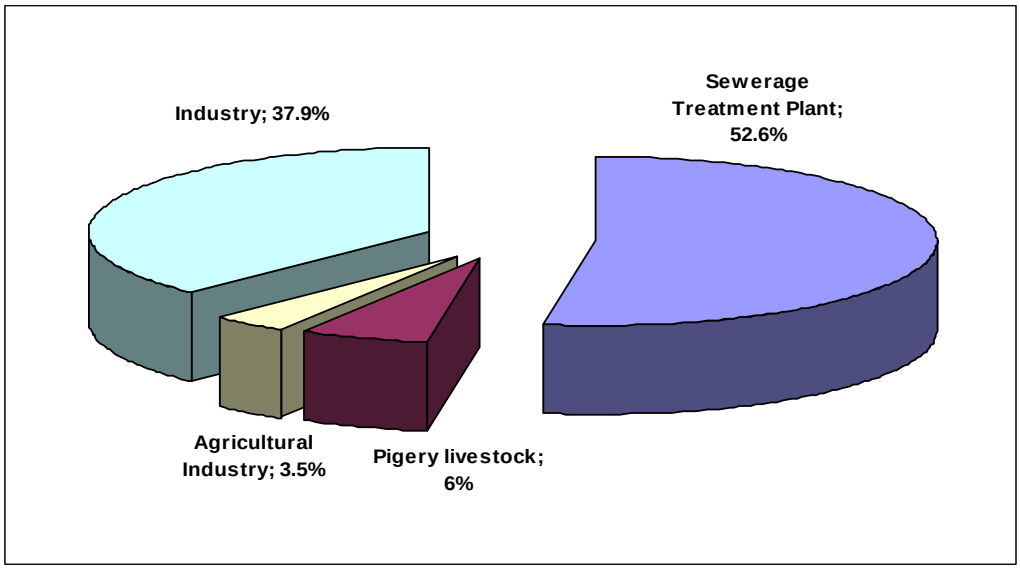

Figure 1.1: Percentage of Activity Contributes to Water Pollution (DOE, 2005)

The best alternative that could be practice is reuse of the effluent in our daily activities. In the recent year, human are more concern and aware of the serious ness on reuse and reclamation water in the world. In many locations where the available supply of fresh water has become inadequate to meet water needs, it is clear that the once-used water collected from communities and municipalities must be viewed not

as a waste to be disposed of but as a resource that must be reused. The concept of reuse is becoming accepted more widely as other parts of the world which is experiencing water shortage (Metcalf and Eddy, 2004).

The use of dual water systems, such as now used in St. Petersburg in Florida and Rancho Viejo in California, is expected to increase in the future (Metcalf and Eddy, 2004). Most of the reuse of wastewater occurs in the arid and semiarid western and southwestern states of the United States. However, the number of reuse projects is increasing in the south especially in Florida and South Carolina (Metcalf & Eddy, 2004). In Malaysia, recycled wastewater is also used for horticultural irrigation, residential garden irrigation and toilet flushing. Typically wastewater is produced in a larger quantity in the cities but used for agriculture in the countryside. Malaysia faces a particularly pressing water resources challenge. It has a largely agricultural population heavily reliant on the over exploitation of groundwater for its survival.

1.2 Objective of the Study

The objectives of this study are:-

(i) To identify the antibacterial properties of *Terminalia catappa* leaves

(ii) To compare the usage of *Terminalia catappa* leaves with chlorination process to kill bacteria in domestic effluent

(iii) To identify the feasibility of reusing domestic effluent treated with *Terminalia catappa* to water landscape plants.

1.4 Scope of the Study

Wastewater samples were collected from oxidation pond at Universiti Teknologi Malaysia (UTM) Skudai. The plant is a major treatment facility in UTM, which processed an average 250 000 m^3/day of wastewater originating from campus and hostels area. The study explores the feasibility of using effluent from domestic wastewater treatment plant to waters landscape plants. Thus, the study will aim at obtaining and analyzing the coliform bacteria data in order to investigate the fecal contamination occurring on plants in the landscape garden.

Terminalia catappa leaf was used as disinfection agent to kill bacteria to ensure public also health. The feasibility of the wastewater reuse practice in Malaysia was also evaluated by comparing the data with other regulations. An open-air landscape garden of 1.5 m x 1.0 m x 0.3 m was designed and constructed with five different shrubs was planted covering the area. The plants are *Coleus artopurpureus (Ca), Cyperus dubius Rottb (Cd), Nyctanthes arbo-tristis L (Na), Panicaum maximum cv. Colonio (Pm)* and *Vinca rosea (Vr).* Grass type *Elephantopus Scaber (Es)* was also planted in the middle region of the garden.

1.5 Significance of Study

Chlorination is by far the most common method of wastewater disinfection and is used worldwide for the disinfection of pathogens before being discharge into receiving streams, rivers or oceans. Although chlorine has always been used to treat polluted water, it still causes problem in terms of residue. One disadvantage is that chlorination of residual organic material can generate chlorinated organic compounds that may also be carcinogenic and harmful to the environment. Residual chlorine or chloramines may also be capable of chlorinating organic material in the natural

aquatic environment. Furthermore, because residual chlorine is toxic to aquatic species, the treated effluent must also be chemically dechlorinated, adding to the complexity and cost of treatment.

Chlorination requires high cost compared to *Terminalia catappa* leaf which is cheaper since it is easily obtain and the process of the producing tannin extract is simpler. Moreover, there are quite a number of *Terminalia catappa* trees in Malaysia. Last but not least, the cost to treat residue will be cut off since it produces lesser residues and is environmentally friendly.