UNIVERSITI PUTRA MALAYSIA

PRODUCTION OF ACTIVATED CARBON FROM LANDSCAPING WASTE FOR THE REMOVAL OF DYES

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FBSB 2015 25

PRODUCTION OF ACTIVATED CARBON FROM LANDSCAPING WASTE FOR THE REMOVAL OF DYES

By:

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Thesis Submitted to the Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, in fulfillment of the requirement for the Degree of Bachelor of Science (Honors) Biotechnology

2015

FAKULTI BIOTEKNOLOGI DAN SAINS BIOMOLEKUL
UNIVERSITI PUTRA MALAYSIA

Date:

LETTER OF PERMISSION

It is thereby to state that I, NORLAILIZA BINTI AHMAD (Matric No: 164752) have done a final year project entitled "**Production Of Activated Carbon From Landscaping Waste For The Removal of Dyes**" under supervision of Professor Dr. Mohd Ali Hassan from the Department of Bioprocess Technology, Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia.

I hereby give permission to my supervisor to write and prepare manuscript from the results of this research to be published in any form, if I do not do so in six (6) months from the date above, in condition that my name is also added as one of the article's authors. The arrangement of the name depends on the supervisor himself.

Yours sincerely,

…….
(NORLAILIZA AHMAD)

FAKULTI BIOTEKNOLOGI DAN SAINS BIOMOLEKUL
UNIVERSITI PUTRA MALAYSIA

APPROVAL SHEET

This thesis entitled "**Production Of Activated Carbon From Landscaping Waste For The Removal of Dyes**" is submitted by NORLAILIZA BINTI AHMAD (Matric No: 164752) in fulfillment of the requirement for the Degree of Bachelor of Science (Honours) Biotechnology in Faculty of Biotechnology and Biomolecular Sciences, Universiti Putra Malaysia, Serdang, Selangor, Malaysia.

Approved by,

…….. Date:

(Professor Dr. Mohd Ali Hassan)
Project Supervisor
Department of Bioprocess Technology
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ABSTRACT

Abstract of thesis presented to the Faculty of Biotechnology and Biomolecular Sciences in fulfillment of the requirement for the Degree of Bachelor of Science (Honours) Biotechnology

PRODUCTION OF ACTIVATED CARBON FROM LANDSCAPING WASTE FOR THE REMOVAL OF DYES

By:

NORLAILIZA AHMAD

JUNE 2015

Supervisor: Professor Dr. Mohd Ali Hassan

Faculty: Faculty of Biotechnology and Biomolecular Sciences

Landscaping waste is one of the municipal solid wastes generated in Malaysia. In this study, a technology was applied to convert the landscaping waste into activated carbon through carbonization and activation processes. The two methods of activation chosen are physical activation and chemical activation. For physical activation, the activated carbon was activated using steam and carbon dioxide; as for chemical activation, phosphoric acid was used as the chemical agent. The physical properties of the activated carbon were then determined by scanning electron microscopic (SEM). The percentage yield for the physical and chemical activation samples were 86.52%

and 90.75% respectively. For the chemical analysis different dyes concentration and different dosage of activated carbon was applied to determine the maximum adsorption capacity and percentage removal of dyes. Dyes are used to represent the colour pollution in wastewater. The activated carbon produced by chemical activation process has higher adsorption capacity and percentage removal compared to physical activation activated carbon. The maximum adsorption capacity of the dye by the activated carbon was 39.96mg/g with 100% percentage dye removal.

ABSTRAK

Abstrak tesis yang dikemukakan kepada Fakulti Bioteknologi dan Sains Biomolekul sebagai memenuhi sebahagian daripada keperluan untuk Bacelor Sains (Kepujian) Bioteknologi

PENGELUARAN KARBON DIAKTIFKAN DARI SISA LANSKAP UNTUK PENYINGKIRAN PEWARNA

Oleh:

NORLAILIZA AHMAD

JUN 2015

Penyelia: Professor Dr. Mohd Ali Hassan

Fakulti : Fakulti Bioteknologi dan Sains Biomolekul

Landskap bahan buangan merupakan salah satu daripada sisa pepejal perbandaran yang dihasilkan di Malaysia. Dalam kajian ini, sida landskap telah ditukar menjadi karbon diaktifkan menggunakan teknologi karbonisasi dan pengaktifan. Kedua-dua kaedah pengaktifan terpilih adalah pengaktifan fizikal dan pengaktifan kimia. Untuk pengaktifan fizikal, karbon diaktifkan dengan menggunakan wap dan karbon dioksida; dan untuk pengaktifan kimia, asid fosforik telah digunakan sebagai agen kimia. Ciri-ciri fizikal karbon diaktifkan ditentukan dengan mengimbas elektron mikroskopik (SEM). Penghasilan peratusan bagi sampel fizikal dan pengaktifan adalah masing-masing 86.52% dan 90.75%. Bagi analisis kimia pewarna yang berbeza kepekatan dan karbon diaktifkan dengan dos berbeza telah digunakan untuk penentuan kapasiti penjerapan

maksimum dan peratusan penyingkiran daripada pewarna. Pewarna yang digunakan mewakili pencemaran warna dalam air sisa. Karbon diaktifkan dihasilkan oleh proses pengaktifan kimia mempunyai kapasiti penjerapan yang lebih tinggi dan peratusan penyingkiran yang lebih tinggi berbanding dengan karbon diaktifkan dirawat secara pengaktifan fizikal. Kapasiti maksima karbon menyerap pewarna ialah 39.96mg / g dengan peratusan penyingkiran pewarna 100%.

ACKNOWLEDGMENT

In The Name of Allah The Most Beneficent and The Most Merciful.

Alhamdulillah, praise to Allah for blessing and always guide my journey of life, ease every single step until I am be able to finish my project and thesis.

First and foremost, I would like to express my gratitude to all the important persons that contribute for my final year project especially to my supervisor Prof Dr. Mohd Ali Hassan for his knowledge sharing, constant supervision and enthusiastic support. I would like to express my appreciation to my co-supervisor Mr Izzudin Ibrahim for his guidance on the project, sharing his valuable opinions and for always troubleshoot the rising problem during my project.

I would like to thank to my family members especially to my parents En Ahmad and Pn Rumini, my siblings who always pray for my success and a brighter future, not to forget, my beloved husband, Ridhwan Fadhil who always be by my best partner in my life and my parents in-law for always provide me support and encourage me to finish the thesis and this final project.

My sincere thanks also go to my lab mates especially my project partner Syafiqa Nazira and Khairiatul Nabilah for sharing knowledge with me while doing the project. Last but not least, special thanks to all my friends that always sharing their equipment's and to be a considerable person and give me some space in the laboratory for carrying out the experiment.

May Allah bless all of us.

Assalamualaikum Warahmatullah.

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LIST OF ABBREVIATIONS

MSW	Municipal solid waste
LWC	Landscaping waste carbon
MB	Methylene blue
MR	Methyl red
MO	Methyl orange
%	Percentage of weight
°C	Celcius
nm	Nanometer ($1x\ 10^{-9}$)
cm^3	Cubic Centimeter
m2/g	meter square per gram
Kg/m3	Kilogram per meter cubic
mm	Millimeter
mg	Milligram
cm	Centimeter
mm	Millimeter
mg	Milligram
M	Molar
OPFC	Oil palm frond carbon
CSC	Coconut shell carbon

Chapter 1

INTRODUCTION

Recently, all over the world started to initiate their awareness on the generation of waste. This issue has become more serious problem since the yearly populations of the world keep increasing. This phenomenon also impacted to the solid waste management in Malaysia. Solid waste generated in urban areas has been increasing year by year due to rapid urbanization and diversity of lifestyles in Malaysia. As a result of rapid urbanization, problems of increasing cost in waste management and securing landfill sites have risen in the country (JPSPN, 2006). According to the National Association of Home Builders Research Center, wood waste contributes the largest percentage of the residential construction and demolition materials (C&D) waste stream (EPA, 2014). Malaysia generated in excess of 15,000 tons of solid waste per day in the form of biomass that consists of forest and mill residues, landscaping wastes, agricultural wastes and municipal waste. Agricultural wastes from agro-based industries are also on the rise. Johore, Selangor, and Perak collectively accounted for 65.7% of the overall identified pollution sources in the agro-based and manufacturing sector (DOE, 2001).

About 2 million tons of agriculture wastes are produced annually in MalaysiaLandscaping waste accounted for 4% of the totals solid waste generated (JPSPN NSP, 2005). Landscaping waste is defined as grass or shrubbery cuttings, leaves, tree limbs and other materials produced from the activities such as care of lawns, shrubbery, vines and trees (EPA Act, 2002). This biomass can be utilized and converted to another useful product that can generate money. If the agriculture waste can be used to produce valuable products, it can prevent the agriculture waste to be disposed in landfill. Most of the agriculture wastes were left at the place where they were generated until decomposed without being discarded. Most of the farmers did not know how disposed their waste in a proper way. For instance, the landscaping waste from Majlis Perbandaran Putrajaya (MPP), such as tree branches was not properly disposed of. Instead, it was shredded and left in the open exposed to the rain and sun. By converting landscaping waste into activated carbon, a higher value product is produced with minimal cost while solving the disposal problem.

In order to reduce the amount of the landscaping waste generated, this research was utilize the landscaping waste by converting it into activated carbon. Activated carbon is

also known as biochar or bioadsorbent. Activated carbon can be prepared from a variety of carbonaceous precursors such as wood, lignite and nut shells (Katesa *et al.,* 2011). Organic waste materials that contain sufficiently high carbon content may be employed to manufacture activated carbon via appropriate activation technique (Tsang *et al.,* 2007). A lot of research has been done on the production of activated carbon from agriculture waste. Landscaping waste is a good precursor due to its high carbon contained. In wood, 50% (w/w) of its component is carbon (Lamlom *et al.,* 2003). The amount of landscaping waste produced from the agricultural waste center can be reduced by converting them into activated carbon. It can reduce the amount of landscaping waste being disposed in landfill. Activated carbon is well known as universal adsorbent and being used all over in the world. It has many applications in industry and has become a demand product to adsorb any liquid and gas phase substance (Katesa *et al.,* 2011). Some of the famous application of activated carbon is in wastewater treatment and industry. In addition, the water pollution threated the environment and it lead to many research done to reduce this pollution (Namasivayam & Sangeetha, 2006). Activated carbon can be used as bioadsorbent in wastewater treatment, air purification and drinking water treatment which removing the taste and odor (T&O) compounds, synthetic organic chemicals (SOCs), and dissolved natural organic matter (DOM) from water (Karanfil, 2006). Air filters and emission absorbers produce from activated carbon are in demand to protect the population against not only industrial gaseous toxins but also against warfare gases, viruses and bacteria. Additionally, activated carbon will continue to be applied in various industrial purification processes related to the production of food and beverages.

Converting landscaping waste into activated carbon involves two stages process which is carbonization and activation. Most of the properties of the activated carbon will be different according to the activation process *(Abdullah et al.,* 2001).There are two methods for activation process namely, physical activation and chemical activation. In physical activation, a raw material is first carbonized and then activated with an oxidizing gas such as steam or carbon dioxide. In chemical activation, a raw precursor is impregnated with a chemical activating agent and carbonized in an inert atmosphere (Alhamed *et al.*, 2006; Tsang *et al.,* 2007). Physical activation method is more preferably since it is environmental friendly (Katesa *et al.,* 2011). Every stage of the experiment is ensured to reduce the environmental pollution. In this study the raw material which is the landscaping waste was first carbonized prior to activation process.

After that, the carbonized sample will undergo two different treatments which is physical and chemical. For physical method the carbonized sample would be exposed with steam. On the other hand for the chemical method the carbonized sample was impregnated with phosphoric acid as the activating agent prior to activation process. Each sample from different process will be observed and characterized using several characterization methods. This method would be adopted and modified from Tsang et al (2007).

The activated carbon sample was characterized on their physical properties and chemical properties. The surface properties of the activated carbon were characterized using Scanning Electron Microscope (SEM) and Brunauer–Emmett–Teller (BET) adsorption model analyzer. From SEM, we can observe the pore size of the activated carbon. BET analysis can measure specific surface area, pore volume, and pore diameter of the activated carbon (Saka, 2012). From the surface area values of BET and SEM micrograph, we can determine whether the activated carbon produced is suitable for the adsorption of dyes from solutions.

Three types of dyes were used which are methylene blue, methyl red and methyl orange were used to test the adsorption capacity of the activated carbon. These dyes represent the pollution of colour that contain in the wastewater. The various colours contain in the wastewater usually comes from textile industry, food industry and metal industry. In this study, the activated carbon produced should be able to remove the colors of these dyes from aqueous solution. Methylene blue is the most common among other dyes of its category, is generally used for dyeing cotton and silk. Methyl orange is usually use in textile industry. The molecules absorbs blue-green light, which makes its solution appear red. Methyl red is a type of azo dyes in which they can be used as indicator to test the acidity of the solution. These dyes have synthetic origin complex aromatic molecular structures, inert, and difficult to biodegrade when discharged into waste streams. This aspect has always been overlooked in their discharge (Hameed et al., 2007).

The objectives of this study are :

i. To produce activated carbon from landscaping waste to remove dyes.

ii. To characterize for their physical properties such as the pore size and surface area using scanning electron microscope as well as their chemical characteristics by adsorption test.

iii. To test the adsorption capacity of the activated carbons on three types of dyes which are methylene blue, methyl red and methyl orange were evaluated by determining their maximum adsorption capacity of the activated carbon. The effectiveness of the activated carbon to adsorb dyes is observed from the ability of the activated carbon to remove the colour of the dyes.

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