THE EFFECT OF ANTHOCYANIN EXTRACTED FROM HERITIERA BORNEENSIS(MENGKULANG) ON DYE SENSITIZED SOLAR CELL(DSSC)

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By

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DEDICATION

Thank you for my parents, Mohd Norzah Bin Isa and Juraiya Binti Mahusain for believing in me, for allowing me to further my studies and also for your unconditional support with my studies. I am honoured to have you as my parents. Thank you for giving me a chance to prove and improve myself through all my walks of life. I hope this achievement will complete our dream together.

ABSTRACT

Dye-sensitized solar cells (DSSC) are the third and latest generation of solar cells that have promising potential in the future. The objective of the study is to investigate the effect of anthocyanin on dye-sensitized solar cells using (*Heritiera borneensis*) sensitizer by current voltage measurement. In wood based industry likes sawmill and plywood, have generated 1.47 million m^3 of waste in high value added products from wood waste. *Heritiera borneensis* (Mengkulang) wastes were ground to size 0.1 to 0.4 mm and solvent extracted with nitric and citric acid for 24 hours to investigate its dyes' potential as a dye sensitizer for dye sensitizer solar cell (DSSC). The colour dyes produced from nitric and citric acid were investigate with using four type of test which were Fourier Transform Infrared Spectroscopy (FTIR), Incident Photon-Current Efficiency (IPCE), Cyclic Voltammetry (CV) and Current-Voltage Measurement (I-V). The sudy found that dyes from these solvents were dominant with carboxyl and hydroxyl groups which important for transferring the photon from the sun to the solar cells. The Mengkulang dyes had a conversion efficiency (η) of 0.154%, with open circuit voltage (V_{oc}) of 0.51V, short circuit current density (I_{sc}) of 0.36 mA cm^{-2} and fill factor (ff) of 84, under the irradiance of 1000 Wm^{-2}. This indicated that the Mengkulang dyes had a high potential as a sensitizer of DSSC.

ABSTRAK

Solar sel sensitif (DSSC) merupakan generasi sel yang ketiga dan terbaru yang mempunyai potensi yang amat bagus pada masa hadapan. Objektif kajian ini adalah untuk menyiasat kesan anthocyanin daripada *Heritiera borneensis* (Mengkulang) untuk digunakan dalam penghasilan DSSC. Dalam industri berasaskan kayu seperti kilang papan dan papan lapis, telah menjana 1.47 juta m^3 sisa habuk yang terhasil daripada produk berasaskan kayu. Selain itu, DSSC adalah salah satu cara dalam menghasilkan produk mesra alam dan produk bernilai tinggi daripada sisa kayu. Sisa buangan *Heritiera borneensis* (Mengkulang) telah dikisar kepada saiz 0.1-0.4 mm dan diekstrak dengan menggunakan asid sitrik dan nitric selama 24 jam untuk mengkaji pewarna sebagai sensitif pewarna untuk menghasilkan sel suria (DSSC). Pewarna yang dihasilkan menggunakan asid sitrik dan nitric dikaji menggunakan empat ujian analisis spectrum (FTIR), analisis photon-arus (IPCE), analisis voltametri berkitar (CV) dan analisis arus-voltan (I-V). Kajian mendapati bahawa larutan pewarna adalah dominan dengan kumpulan karboksil dan hidrosil dimana sangat penting untuk memindahkan foton daripada matahari kepada sel-sel suria. Pewarna Mengkulang mempunyai kecekapan penukaran (η) sebanyak 0.154%, dengan voltan litar terbuka (V_{oc}) sebanyak 0.51V, ketumpatan arus litar pintas (I_{sc}) 0.36 mA cm^{-2} dan pengisian faktor sebanyak 84, yang terhasil di bawah sinaran sekuat 1000 Wm^{-2}. Ini menunjukkan bahawa pewarna Mengkulang mempunyai potensi yang tinggi sebagai sensitif untuk DSSC.

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APPROVAL SHEET

I certify this research project entitle "**EXPLORING THE POTENTIAL OF *HERITIERA BORNEENSIS* (MENGKULANG) EXTRACTION FOR PHOTO SENSITIZER**" by Muhammad Naqiuddin Bin Mohd Norzah has been examined and approved as partial fulfilment of the degree of Bachelor of Wood Science Technology in Faculty of Forestry, Universiti Putra Malaysia.

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LIST OF ABBREVIATIONS

FTIR	Fourier transform infrared spectroscopy
DSSC	Dye-Sensitized Solar Cell
TiO^2	Titanium dioxide
FTO	Flourine doped Tin Oxide
FF	Fill factor
IPCE	Incident Photon-Current Efficiency
CV	Cyclic Voltammetry

CHAPTER 1

INTRODUCTION

1.1 Background Study

Malaysia is one of the countries that have tropical rainforest that can be classified as mega diversity. This forest is believed to be about 130 million years old and it covered two thirds of the total area of forest in Malaysia. It is the combination of variety type of forests, although they are mainly Dipterocarp forests. The estimation of 23,500 species of vascular plant in Malaysia which are divided into 8,500 species in peninsular Malaysia and the rest of 15,000 in Sabah and Sarawak. The forests in East Malaysia are estimated to be habituated with around 2,000 tree species, and are one of the most biodiversity area in the world, with 240 different species of trees every hectare (Hock, 2007).

Wood in Malaysia are commonly used as raw material by a large domestic wood manufacturing industry. Many products such as plywood and furniture molding were made from tropical rainforest woods such as merbau, keruing, kapur, jelutong, rengas, ramin and many others. Due to the excessive uses of these woods, many countries including Malaysia did a lot of researches to generate renewable and usable energy using those wood waste.

1.2 Renewable Energy

Energy is required in almost our daily life including agriculture, transportation, telecommunication and industrial activities that influence the economic

growth. The economic growth is measure by gross domestic product (GDP) and in Malaysia, GDP is correlates almost exactly with the energy consumption of the country (Shafie et al., 2011). Malaysia is with a plentiful and relatively cheap supply of conventional fossil energy resources such as oil, gas, and coal as well as renewable energy sources such as hydropower, biomass and solar. Past and current economic growth in the country have been primarily fueled by fossil fuels (Yusoff, 2006). But energy demand in Malaysia always increasing everyday due to the need of country to maintain the economic growth.

Malaysia energy sector is still heavily dependent on non-renewable fuel such as crude oil, natural gas and coal as a source of energy. Economic growth in Malaysia depends on the energy consumption; the increase in energy consumption is expected to be in uptrend around 6–8% annually based on nation economic growth. These non-renewable fuels are gradually depleting and contribute huge amount of greenhouse gas emission (Ong et al., 2011). The energy generates from the combustion of fossil fuels has simultaneously created several environmental concerns which can threaten the sustainability of our ecosystem (Ong et al., 2011). One of the primary concerns will be the emissions of greenhouse gases and other types of air pollutants such as hydrocarbons, nitrogen oxide and volatile organic compounds (Masjuki et al., 2002). So, it will be better if the researchers can find a method to produce renewable energy that does not give any negative effect to the environment.

According to the Prime Minister Department of Malaysia (2010), the energy demand of Malaysia in 2009 is 16,132 MW, compared to 10 years before the

demand of electricity is just 9690 MW. The rising in electricity demand from 1999 is about 66.5%. This rapid increase in demand is due to the high economic development rate of Malaysia (Shafie et al., 2011).According to the Ministry of Housing and Local Government (2005), in 2009 the population of Malaysian will reach 25.4 million people, and by the year of 2020 almost 75% will live in urban areas and the population will have almost doubled since 1980. So that, the researcher need to do a lot of research to produce an abundant amount of renewable energy to fulfill the need of every people in this country. It is also will be better if the researchers can find a method to produce renewable energy that does not give any negative effect to the environment.

The cost of production of the energy also have to be taken into consideration to. Basically, the cost of production of renewable energy still very expensive. The Malaysia Federal Government and the Non-Financial Public Enterprises (NFPEs) have invested a substantial amount of allocation to continue providing an adequate, reliable and reasonably priced supply of electricity to the people (Oh et al., 2010). For example, a total of RM27.9 billion (US$7.75 billion) was spent in the electricity supply sector under the 8th Malaysia Plan to undertake electricity sector programs in generation, transmission, distribution as well as rural electrification. The amount is expected to increase to RM30 billion (US$8.33 billion) under the 9th Malaysia Plan. With these investments and coupled with strong policy measures, the electricity coverage in Malaysia is expected to increase to 95.1% in 2010 from 89.5% in 2000, with the rural electrification rate in Peninsular Malaysia currently at

99% (Mansor, 2008). So, it is very important to have the advancement in producing renewable energy that are environmental friendly and cheap.

1.3 Problem Statement

The nowadays source of energy such as fuel and coal are very expensive. It gave a lot of pressure towards the economy of a country because the amount of energy that been used by the people kept increasing for one day to another day. The amount of money needed was also very expensive to provide and maintain the source of energy that every country need. It also can give negative impact to the environment. For example, the usage of dam to generate electricity from the flow of water need a lot of forest area to be destroy. It also gives direct impact toward reducing the area that can collect rain water and also can damage the structure of the soil on that area. So it is important and essential for the researchers to find a new source of energy especially searching the potential of wood waste in producing energy so that the energy will be renewable, cheap and environmental friendly.

1.4 Justification

Generally, the wood waste especially wood sawdust are burned to generate bio-energy without proper considering the potential of its extractive value that can be converted into a green product such as photo sensitizer for dye sensitized solar cells(DSSC). The use of photo sensitizer from wood extractive will increase the value added by product as well as to reduce the conventional solar cells manufacturing cost in the future and alternatively to

promote a new green product that can become better product than conventional solar cells.

1.5 Objective

The objectives of this experiment are:-

1. To determine the effect of anthocyanin extracted from Mengkulang (*Heritiera borneensis*) on the dye-sensitized solar cells.
2. To investigate the light absorption of photochemical in Mengkulang (*Heritiera borneensis*) extracted using chemical solvent.

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