



Faculty of Engineering

**Synthesis and Characterization of Activated Carbon from Dabai
(*Canarium odontophyllum*) Nutshell for Removal of Water Pollutants**

Ahmad Adzhar bin Mohd Khairulzaim

**Master of Engineering
2024**

Synthesis and Characterization of Activated Carbon from Dabai (*Canarium
odontophyllum*) Nutshell for Removal of Water Pollutants

Ahmad Adzhar bin Mohd Khairulzaim

A thesis submitted

In fulfilment of the requirements for the degree of Master of Engineering

(Mechanical Engineering)

Faculty of Engineering

UNIVERSITI MALAYSIA SARAWAK

2024

DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Malaysia Sarawak. Except where due acknowledgements have been made, the work is that of the author alone. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

A handwritten signature in black ink, consisting of a large loop followed by a few strokes, positioned above a dotted line.

Signature

Name : Ahmad Adzhar bin Mohd Khairulzaim

Matric No. : 19020199

Faculty of Engineering

Universiti Malaysia Sarawak

Date: 4 July 2024

ACKNOWLEDGEMENT

I would like to take this opportunity to those who have contributed directly or indirectly to this guidebook, especially Associate Professor Ts. Dr. Md Rezaur Rahman and Dr Lid yana Roslan, my supervisors, Mr Mohd Khairulzaim Abdullah and Madam Lily Yusuf, my beloved parents, and my family members.

My sincere gratitude to the Centre for Graduate Studies and Faculty of Engineering, for the facility, guidance, advice, and support given during my period of study in Universiti Malaysia Sarawak.

Finally, I would like to thank the management of the Universiti Malaysia Sarawak for making possible for me to complete my study here in Sarawak.

ABSTRACT

This research is conducted to explore the potential of utilizing dabai nutshell as the precursor for the purpose of synthesizing biochar and activated carbon (AC) for the purpose of removing water pollutants. Dabai nutshell is commonly thrown away as waste instead of being utilized for industrial purpose. Previous studies on chemical activation of the biomass do not meet the required properties of the AC, and do not include the optimization of carbonization temperature. The potential of the AC from dabai nutshell for removal of heavy metal ions are not explored in prior studies. Inert gases and complex equipment set up to provide oxygen-less atmosphere for the synthesis of AC are not available in rural areas, thus further studies are required to determine the alternatives for the inert gas. This research aimed to synthesise the AC from Dabai nutshell using chemical activation and carbonization (both processes are without inert gas flow) and characterize it using several analytical techniques. This work also studies on the effect of different chemical activating agents with different concentration on the synthesis of AC, to optimize the carbonization temperature and to apply the AC on removal of selected water pollutants. The dabai nutshell underwent physical treatment to clean, dry and reduce its size down to 1 mm. The biomass then carbonized under different atmosphere, and at different temperature, in order to perform optimization study for the process's temperature. The resulting biochar is then activated using sodium hydroxide (NaOH), potassium chloride (KCl) or hydrochloric acid (HCl). The synthesized AC were then characterize using several analytical methods and applied on removal of dye methylene blue and heavy metal ions (zinc, chromium, and lead). The results showed that the biochar is dominated by carbon and oxygen, and the percentage yield and ash content of the biochar are more than 26% and less than 4.00%, respectively. The nitrogen

adsorption isotherm of the biochar is similar to Type I of IUPAC classification, and biochar is observed to have the surface area more than 370 m²/g. The optimization of the carbonization temperature on synthesizing biochar that met the set criteria concluded that 721.469 °C is the optimum temperature. The biochar derived without inert gas flow during carbonization have comparable properties with the biochar derived under nitrogen and argon gas flow. AC derived through chemical activation using NaOH have comparable BET surface properties with commercial AC, with micropores properties, BET surface area of more than 328 m²/g, and total pore volume of more than 0.194 m³/g. The nitrogen adsorption isotherms are similar to Type II isotherm of the IUPAC categorization across all replicates. AC replicates derived through HCl and KCl activation are dominated with carbon and oxygen and have ash content less than 3%. All AC replicates however are having low MB adsorption uptake, lower than the standard (60-120 mg/g), and the kinetic study of MB adsorption reveals that the most suited model to describe the MB adsorption on the AC replicates are pseudo-second-order model and Elovich kinetic model. All AC replicates have more than 35% removal of heavy metal ions with initial concentration of 30 ppm. These findings conclude that dabai nutshell are suitable to be utilized as precursor for AC, with carbonization and chemical activation are performed on the precursor without the use of inert gas flow. The resulting AC also performed excellent adsorption to reduce the concentration of heavy metal ions.

Keywords: Dabai nutshell, chemical activation, activated carbon, adsorption, carbonization temperature, optimization, dye methylene blue, heavy metal ions.

Sintesis dan Perwatakan Karbon Diaktifkan daripada Kulit Kacang Dabai (*Canarium odontophyllum*) untuk Penyingkiran Bahan Pencemaran Air

ABSTRAK

Kajian ini dilaksanakan bagi mengenali potensi penggunaan kulit kacang dabai sebagai bahan asas penghasilan bio-arang dan karbon teraktif (AC) untuk tujuan penyingkiran bahan pencemar air. Kulit kacang dabai sering dibuang dan tidak dimanfaatkan untuk tujuan industri. Kajian terdahulu ke atas pengaktifan kimia pada biojisim berkenaan tidak menepati ciri AC, dan tidak merangkumi pengoptimuman suhu pengkarbonan. Kajian terdahulu juga tidak mengenali potensi AC daripada kulit kacang dabai untuk penyingkiran ion logam berat. Gas lengai dan kelengkapan peralatan yang kompleks bagi menghasilkan keadaan tanpa oksigen untuk penghasilan karbon teraktif juga tiada di kawasan pedalaman, maka kajian selanjutnya diperlukan untuk menemui alternatif kepada gas lengai. Kajian ini bertujuan untuk menghasilkan AC daripada kulit kacang Dabai melalui pengaktifan kimia dan pengkarbonan (kedua-dua proses dilaksanakan tanpa aliran gas lengai) dan mencirikan AC berkenaan melalui beberapa kaedah analitikal. Kajian ini juga akan meneliti kesan penggunaan agen pengaktifan kimia yang berbeza, dengan kepekatan yang berbeza ke atas penghasilan AC, mengoptimumkan suhu pengkarbonan dan menggunakan AC berkenaan dalam penyingkiran bahan pencemar air yang terpilih. Kulit kacang dabai terlebih dahulu melalui rawatan fizikal, dengan membersihkan, mengering dan mengurangkan saiz sehingga 1 mm. Biojisim berkenaan kemudian dikarbonkan di bawah keadaan atmosfera yang berbeza, dan suhu yang berbeza bagi melaksanakan kajian pengoptimuman ke atas suhu proses berkenaan. Bio-arang yang telah dihasilkan kemudiannya diaktifkan menggunakan natrium hidroksida (NaOH), kalium klorida (KCl) atau asid hidroklorik (HCl). AC yang telah dihasilkan kemudiannya dicirikan

melalui beberapa kaedah analitikal dan digunakan untuk penyingkiran pewarna metilena biru dan ion logam berat. Keputusan dari kajian ini menunjukkan bahawa bio-arang yang terhasil didominasi oleh karbon dan oksigen, dan peratusan hasil dan kandungan abu pada bio-arang masing-masing adalah 26% dan kurang daripada 4.00%. Isoterm penjerapan nitrogen bagi bio-arang ini adalah serupa dengan Jenis I dalam klasifikasi IUPAC, dan bio-arang diperhatikan mempunyai luas permukaan melebihi 370 m²/g. Pengoptimuman untuk suhu pengkarbonan yang menepati kriteria yang telah ditetapkan menyimpulkan bahawa 721.469 °C ialah suhu optimum untuk proses berkenaan. Bio-arang yang dihasilkan tanpa menggunakan aliran gas lengai mempunyai ciri-ciri yang setanding dengan bio-arang yang dihasilkan menggunakan aliran gas nitrogen dan argon. AC yang dihasilkan melalui pengaktifan kimia menggunakan NaOH adalah setanding dengan AC komersial, dengan mempunyai ciri-ciri mikropori, luas permukaan BET melebihi 328 m²/g dan jumlah isi padu pori melebihi 0.193 m³/g. Isoterm penjerapan nitrogen bagi kesemua replika AC berkenaan adalah serupa dengan Jenis II dalam klasifikasi IUPAC. Replika AC yang dihasilkan melalui pengaktifan HCl dan KCl didominasi oleh karbon dan oksigen, dan mempunyai kandungan abu kurang daripada 3%. Namun, kesemua replika AC mempunyai penjerapan MB yang rendah, lebih rendah daripada standard (60-120 mg/g) dan kajian kinetik terhadap penjerapan MB mendapati model yang paling sesuai menjelaskan penjerapan MB ke atas kesemua replika AC adalah model pseudo-urutan-kedua dan model kinetik Elovich. Kesemua replika AC telah mengurangkan sekurang-kurangnya 35% daripada kepekatan asal (30 ppm) ion logam berat. Dapatan ini menyimpulkan bahawa kulit kacang dabai sesuai digunakan sebagai bahan asas untuk AC, dengan pengkarbonan dan pengaktifan kimia dilakukan pada bahan asas tanpa menggunakan aliran gas lengai. AC yang terhasil

juga melakukan penjerapan yang sangat baik untuk mengurangi kepekatan ion logam berat.

Kata kunci: Kulit kacang dabal, pengaktifan kimia, karbon teraktif, penjerapan, suhu karbonisasi, pengoptimuman, pewarna biru methylene, ion logam berat

TABLE OF CONTENTS

	Page
DECLARATION	i
ACKNOWLEDGEMENT	ii
ABSTRACT	iii
ABSTRAK	v
TABLE OF CONTENTS	viii
LIST OF TABLES	xiii
LIST OF FIGURES	xvi
LIST OF ABBREVIATIONS	xix
LIST OF NOMENCLATURE	xx
CHAPTER 1 INTRODUCTION	1
1.1 Study Background	1
1.2 Problem Statement	4
1.3 Research Gap	5
1.4 Hypothesis	6
1.5 Aim and Objectives	7
1.6 Scope of Research	7
CHAPTER 2 LITERATURE REVIEW	9
Overview	9
2.1 Fundamentals of Dabai	10

2.1.1	Properties of Dabai	10
2.1.2	Advantages of Dabai Nutshell	14
2.2	Activated Carbon (AC)	15
2.2.1	Mechanism of Adsorption	17
2.2.2	Porosity of Activated Carbon	25
2.2.3	Synthesis of AC	26
2.2.4	Utilization of Lignocellulosic Material/Biomass as Precursor for AC	37
2.2.5	Forms of Activated Carbon	38
2.2.6	AC in Wastewater Treatment	39
2.2.7	Earlier Research on Dabai Nutshell as An Adsorbent	44
2.3	Water Pollutants and Available Treatment	45
2.3.1	Causes of Water Pollution	45
2.3.2	Dye and Heavy Metal Ions as Water Pollutants and Contaminants	47
2.3.3	Available Alternatives and Treatments for Water Pollution	49
2.4	Conclusion	51
CHAPTER 3 MATERIALS AND METHODS		52
Overview		52
3.1	Research Variables	52
3.1.1	Materials	53
3.1.2	Apparatus	54

3.2	Synthesis of Activated Carbon	55
3.2.1	Preparation of Precursor	56
3.2.2	Study on Carbonization Parameter	57
3.2.3	Chemical Activation of Dabai Biochar	60
3.3	Characterization of Biochar and Activated Carbon	63
3.3.1	Percentage Of Yield of Dabai Biochar and Activated Carbon	63
3.3.2	Ash Content of Dabai Biochar and Activated Carbon	64
3.3.3	Scanning Electron Microscopy-Energy Dispersive X-Ray Spectrometer (SEM-EDX) of Dabai Biochar and Activated Carbon	64
3.3.4	Fourier Transform Infrared (FTIR) Spectra of Dabai Biochar and Activated Carbon	65
3.3.5	Brunauer, Emmett, and Teller (BET) Surface Analysis Dabai Biochar and Activated Carbon	65
3.4	Optimization on Carbonization	65
3.5	Adsorption Study and Removal of Water Pollutants	66
3.5.1	Methylene Blue (MB) Adsorption	67
3.5.2	Heavy Metal Ion Adsorption	68
CHAPTER 4 STUDY ON CARBONIZATION PARAMETER AND IT'S OPTIMIZATION		69
	Overview	69
4.1	Characteristics of Biochar	69

4.1.1	Percentage Of Yield and Ash Content of The Biochar	69
4.1.2	Fourier-Transform Infrared Spectra Analysis	70
4.1.3	Surface Morphology of The Biochar	71
4.1.4	Nitrogen Adsorption Isotherm and BET Surface Properties for The Dabai Biochar	73
4.1.5	Elemental Mass Percentage of The Biochar	74
4.2	Study On Carbonization Parameter for Biochar	76
4.2.1	Carbonization Temperatures	76
4.2.2	Optimization of Carbonization Temperature	84
4.2.3	Carbonization Atmosphere	97
CHAPTER 5 STUDY ON DABAI NUTSHELL ACTIVATED CARBON AND ITS CHARACTERIZATION		100
	Overview	100
5.1	Fourier-Transform Infrared Spectra of the Activated Carbon	100
5.2	Scanning Electron Microscopy (SEM) Images of Activated Carbon	103
5.3	Energy Dispersive X-ray (EDX) Spectra and Elemental Analysis of Activated Carbon	107
5.4	Percentage of Ash Content of the Activated Carbon	114
5.5	Brunauer-Emmett-Teller (BET) Surface Area Analysis of Activated Carbon	115
5.5.1	Surface Area Analysis of the Activated Carbon	116
5.5.2	Nitrogen Adsorption Isotherm of the Activated Carbon	117

CHAPTER 6	ADSORPTION PERFORMANCE OF ACTIVATED CARBON	119
Overview		119
6.1	Adsorption of Methylene Blue Solution by Dabai AC.	119
6.1.1	Adsorption of 30 ppm MB Solution on Dabai AC Replicates	119
6.1.2	Kinetic Study of MB Adsorption on Dabai AC Replicates	121
6.2	Adsorption of Heavy Metal Ions Solutions on Dabai AC Replicates	125
CHAPTER 7	CONCLUSION	130
7.1	Conclusion	130
7.2	Recommendations	132
REFERENCES		133
APPENDIX		161

LIST OF TABLES

	Page
Table 2.1 Six dabai fruit genotypes (n = 10) were measured for length, breadth, and pulp thickness, as well as form (sphericity index and aspect ratio) (Chua et al., 2015)	11
Table 2.2 Fruit mass fraction in six typical genotypes of dabai fruits (Chua et al., 2015).	12
Table 2.3 A brief review of the types of adsorption isotherms (Kecili and Hussain, 2018).	18
Table 2.4 Several studies on chemical activation method for synthesis of activated carbon.	31
Table 2.5 Comparison on chemical activation performed by several different types of chemical activating agent.	34
Table 2.6 Examples of lignocellulosic material/biomass utilized as adsorbent material.	38
Table 2.7 Organics susceptible and not susceptible for adsorption onto AC (Çeçen, 2011).	40
Table 2.8 Malaysian standard for powdered activated carbon for the use of potable water supply (Department of Standards Malaysia, 2005)	40
Table 2.9 Indonesian standard for activated carbon (Hanum et al., 2017).	41
Table 2.10 Several methods towards water treatments	49
Table 3.1 Research variables for the synthesis of AC from dabai nutshell.	52
Table 3.2 Materials and its specifications	53
Table 3.3 Apparatus and its specifications	54

Table 3.4	Kinetic model of adsorption studied	68
Table 4.1	Yield percentage of dabai biochar	70
Table 4.2	The percentage of ash contained in the char.	70
Table 4.3	BET surface area for the Dabai biochar	74
Table 4.4	The mass proportion of components in Dabai biochar.	75
Table 4.5	The mass and atomic percentage of the elements found in raw dabai nutshell and biochars obtained at various temperature settings.	78
Table 4.6	Yield percentage for biochars derived at different carbonization temperatures.	79
Table 4.7	Ash content for the replicates for each carbonization temperature setting.	81
Table 4.8	BET surface properties of the biochars derived at 400-800 °C	84
Table 4.9	Experimental design and resulting properties of the char derived from dabai nutshell at different carbonization temperatures.	85
Table 4.10	The analysis of variance for the cubic model for the percentage of yield as affected by the carbonization temperature.	86
Table 4.11	Fit statistics of the cubic model for the percentage of yield of the dabai char	87
Table 4.12	ANOVA for Cubic model for the ash content of the char	89
Table 4.13	Fit statistics of the cubic model for ash content of the dabai char	90
Table 4.14	ANOVA for the linear model to predict the BET surface area of the biochar.	91
Table 4.15	Fit statistics of the linear model	91
Table 4.16	The results of ANOVA on the total pore volume of the biochars	93

Table 4.17	Fit statistics of the linear model	93
Table 4.18	Different atmosphere conditions for carbonization of raw dabai	99
Table 5.1	Elemental mass percentage of AC from NaOH activation	108
Table 5.2	Elements mass percentage for AC from KCl activation	109
Table 5.3	Elements mass percentage for AC from HCl activation	111
Table 5.4	Surface area properties of the NaOH-AC replicates.	117
Table 6.1	Kinetic parameters of adsorption of MB onto NaOH-AC, HCl-AC and KCl-AC	123
Table 6.2	Adsorption of lead ions by AC replicates	126
Table 6.3	Zn ions removal using Dabai AC replicates	128
Table 6.4	Chromium adsorption using Dabai AC replicates	129

LIST OF FIGURES

	Page
Figure 2.1	Graphical understanding for the literature review. 9
Figure 2.2	Male flower morphology of dabai trees in general (Ting et al., 2017). 13
Figure 2.3	A cross section of Dabai nutshell 13
Figure 2.4	EDX spectrum of Dabai nutshell (Vicinisvarri et al., 2014) 14
Figure 2.5	6 types of isotherms of adsorption (Donohue and Aranovich, 1998). 18
Figure 2.6	General step for the synthesis of activated carbon. 27
Figure 2.7	Stages of carbonization (Chowdhury et al., 2013; Reza et al., 2020). 28
Figure 2.8	(a) Powdered AC, (b) pellets of AC, (c) extruded AC, while (d) and (e) is granular AC (Carabineiro et al., 2012). 39
Figure 2.9	Several sources of water pollution (Afroz et al., 2014) 46
Figure 2.10	Several types of dyes and its applications (Al-Tohamy et al., 2022) 47
Figure 3.1	Experimental procedure for the synthesis of activated carbon from dabai nutshell. 56
Figure 3.2	Dabai nutshell (uncracked) 57
Figure 3.3	Reducing the size of dabai nutshell using heavy duty grinder. 57
Figure 3.4	LT Furnace (conventional furnace) 59
Figure 3.5	Carbonization temperature graph vs time 59
Figure 3.6	High temperature muffle furnace, KSL-1700X 60
Figure 3.7	Ash content determination. 64
Figure 3.8	Design Matrix of Optimization of Carbonization Temperature. 66
Figure 4.1	The spectra of FTIR analysis for the dabai replicates; (a) Replicate 1, (b) Replicate 2, (c) Replicate 3 and (d) raw dabai nutshell 71

Figure 4.2	SEM figures for Dabai char replicates and raw dabai nutshell	72
Figure 4.3	Nitrogen adsorption-desorption isotherm for dabai biochar	73
Figure 4.4	EDX spectra of dabai nutshell and biochars replicates derived from the precursor.	75
Figure 4.5	SEM images of dabai biochar synthesized from different temperature settings.	77
Figure 4.6	Average yield percentage of the biochars synthesised at different temperatures.	80
Figure 4.7	Average ash content of biochar replicates synthesised at different temperature setting.	81
Figure 4.8	Nitrogen adsorption isotherm for biochars derived at 400 to 800 °C.	82
Figure 4.9	The model graph, comparing the predicted data with the actual data of the percentage of yield for the replicates of dabai char derived at different carbonization temperatures.	88
Figure 4.10	The model graph, comparing the predicted data with the actual data of the ash content for the replicates of dabai char derived at different carbonization temperatures.	90
Figure 4.11	Model graph of the predicted value of BET surface area as affected by the carbonization temperature as compared to the experimental data.	92
Figure 4.12	Model graph showing the predicted values of total pore volume of the biochar as affected by the carbonization temperature, compared to the actual data.	94
Figure 4.13	Optimization solution for the carbonization temperature	96
Figure 5.1	FTIR Spectra for NaOH-AC replicates	101

Figure 5.2	FTIR spectra of HCl-AC replicates	102
Figure 5.3	FTIR spectra of KCl-AC	103
Figure 5.4	SEM images for NaOH AC at different impregnation concentrations.	104
Figure 5.5	SEM images of activated carbon produced with different concentration of KCl (a) 1%, (b) 4%, (c) 7%, (d) 10% and (e) 13%.	105
Figure 5.6	SEM images of activated carbon produced with different concentration of HCl (a) 1%, (b) 4%, (c) 7%, (d) 10% and (e) 13%.	106
Figure 5.7	NaOH-AC EDX Spectrum	109
Figure 5.8	KCl-AC EDX spectrum	110
Figure 5.9	HCl-AC EDX spectrum	112
Figure 5.10	Oxygen mass percentage for the AC replicates	113
Figure 5.11	Carbon mass percentage for the AC replicates	114
Figure 5.12	Ash content for AC replicates	115
Figure 5.13	Nitrogen adsorption isotherm of the NaOH-AC replicates	118
Figure 6.1	MB removal performance for the AC replicates	121
Figure 6.2	Adsorption of 10 ppm MB solution over the time using the AC replicates.	122
Figure 6.3	Comparison of the experimental data of 10 ppm MB adsorption on (a) NaOH-AC, (b) HCl-AC and (c) KCl-AC, towards kinetic models of adsorption	125
Figure 6.4	Removal percentage of lead ions using dabai AC	127
Figure 6.5	Removal performance of Zn ion using Dabai AC	128

LIST OF ABBREVIATIONS

AC	Activated Carbon
ASTM	American Society for Testing and Materials
BET	Brunauer-Emmett-Teller
COD	Chemical Oxygen Demand
EDX or EDS	Energy Dispersive Xray Spectroscopy
FTIR	Fourier Transform Infrared Spectroscopy
HCl-AC	AC derived though hydrochloric acid, HCl activation
ID	Intra-particle diffusion kinetic model
IUPAC	International Union of Pure and Applied Chemistry
KCl-AC	AC derived though potassium chloride, KCl activation
MB	Methylene Blue
NaOH-AC	AC derived though sodium hydroxide, NaOH activation
PFO	Pseudo-first-order adsorption kinetic model
PSO	Pseudo-second-order adsorption kinetic model
SEM	Scanning Electron Microscope

LIST OF NOMENCLATURE

H_3PO_4	Phosphoric acid
HCl	Hydrochloric acid
KCl	Potassium Chloride
KOH	Potassium hydroxide
NaOH	Sodium Hydroxide

CHAPTER 1

INTRODUCTION

1.1 Study Background

Responsibility towards curing Mother Earth from pollution is one of the major concerns worldwide. Reducing the various pollutants through numerous methods are necessary for each nation on this planet, which induce countless efforts to explore all resources and procedures available. Current development in the combat against water pollution includes the physical treatment such as sedimentation and filtration, and chemical treatments such flocculation, coagulation, adsorption, and ion exchange methods (Saravanan et al., 2021). For adsorption, one of the common methods being deployed is the utilization of highly porous activated carbon.

Ukanwa et al. (2019) stated that activated carbon (AC) is a carbonaceous material produced by thermal or thermochemical processes from coal or biomass. ACs are distinguished by their well-developed pore morphology, extraordinary surface area, electron-conducting amphoteric tendencies, and high adsorptive capacity (Pezoti et al., 2016). The activated carbon has a variety of uses in the treatment of wastewater, including the removal of metal ions and dye from aqueous solutions as well as the sterilization of drinking water. (Ioannidou & Zabaniotou, 2007).

Conventionally, AC is developed using coal, wood and coconut shells as described by Crini et al. (2019). Non-conventional AC are synthesized from solid biomass waste containing high percentage of carbon, and industrial byproducts such as sewage sludges and waste tires. Utilization of solid biomass such as date stones, palm kernel husks, nutshells and

palm fruit bunch is studied thoroughly to determine the suitability of the raw materials as the precursor in AC production (Crini et al., 2019).

One of the most underutilized lignocellulosic wastes in Borneo is Dabai (*Canarium odontophyllum*). The dabai fruit, leaves, and stem (in terms of extract), is proven by various studies to have pharmaceutical advantages, ranging from potential diabetic medication to cancer treatment (Fredalina Basri, 2015; Hamzah et al., 2022). According to Kasron et al. (2020), in 2018, Dabai had the greatest crop area and led overall indigenous fruit production in Malaysia, accounting for 29% of land area and 15% of production. However, it is different for the nutshell of the fruit, where this material is usually thrown away after its flesh being consumed, and very little research is made on the nutshell in order to determine its value. Dabai nutshell, for instance, has a lot of undiscovered value since it could potentially be used as a precursor in the production of activated carbon. Some folks like to boil and dry the nutshell before eating the nut within. The nutshell is very hard, where it requires nutcrackers to open it, and heavy-duty grinder to further crush it into powders. The biomass also took long time to be decomposed naturally. By looking at the possibility of using the Dabai nutshell as raw material for the synthesise of AC, it could open up fresh opportunities for using Dabai for commerce., instead of just being thrown away as waste. Additionally, this will result in a significant increase in the number of available positions for labour. Furthermore, the expansion of Dabai tree plantation areas would bring value to the state economy, particularly through the use of Dabai by-products as a precursor to the production of activated carbon. These advantages will increase the value of agricultural goods and enable a broader range of low-cost solutions to water pollution (Ioannidou & Zabaniotou, 2007).