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**REMOVAL OF METHYL RED USING  
COCONUT COIR AND COCONUT COIR  
ACTIVATED CARBON AS ADSORBENT**

by

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## DECLARATION

I declare that this thesis entitled “Removal of Methyl Red using Coconut Coir and Coconut Coir Activated Carbon as Adsorbent” is the result of my own research except as cited in the references. The thesis has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

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## LIST OF SYMBOLS

%	-	Percentage
L	-	Liter
mL	-	Mililiter
°C	-	Degree Celcius
UV-Vis	-	Ultra Violet -Visible
Rpm	-	Revolution per minute
Mm	-	Milimeter
M	-	Molar
μL	-	Microliter
g	-	Gram
min	-	Minute
CC	-	Coconut Coir
CCAC	-	Coconut Coir Activated Carbon

## Removal of Methyl Red using Coconut Coir and Coconut Coir Activated Carbon as Adsorbent

### ABSTRACT

In this study, adsorption technique was employed for removal Methyl Red dye. Methyl red dye is azobenzenecarboxylic acid which is well known used in paper printing and textile dyeing. Increasing of usage dyes has shown increasing of pollution in water where it give severely effect to human health and aquatic life. The adsorption of Methyl Red dye was carried out using agriculture waste which is coconut (*Cocos nucifera*) coir to optimize the effect of contact time, initial concentration, adsorbent dosage and pH and determine the efficiency of raw and activated carbon of coconut coir in removing methyl red dye. Batch studies were performed to evaluate the effects of various parameters: (contact time, initial concentration, adsorbent dosage and pH), on adsorption capacity of methyl red dye. The results showed that raw coconut coir removed methyl red at maximum capacity at 40 minutes while activated carbon at 20 minutes. Both the adsorbents have removed the dye at highest capacity was at 20 mg/L and pH 2. While the dosage were different where the raw coconut coir at 0.05 g while activated carbon at 0.1g. Coconut coir activated carbon was found to be more effective than raw coconut coir as adsorbent in removing methyl red dye where it remove 50% until 80% while raw coconut coir only removed about 40% until 60%.

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## **Penyingkiran Methyl Red menggunakan Sabut Kelapa dan Karbon Sabut Kelapa Diaktifkan sebagai Bahan Penjerap**

### **ABSTRAK**

Dalam kajian ini, teknik penjerapan telah digunakan untuk menyingkirkan pewarna Metil Merah. Metil Merah adalah asid azobenzanakarboxilik yang terkenal dalam penggunaan percetakan kertas dan pencelupan tekstil. Peningkatan penggunaan pewarna telah menunjukkan peningkatan pencemaran di dalam air di mana ia memberikan kesan teruk kepada kesihatan manusia dan hidupan akuatik. Penjerapan Metil Merah telah dijalankan dengan menggunakan sisa pertanian iaitu sabut kelapa (*Cocos nucifera*) untuk mengoptimumkan kesan masa, kepekatan permulaan, dos penjerap dan pH serta menentukan kecekapan sabut kelapa mentah dan sabut kelapa karbon diaktifkan dalam menyingkirkan pewarna Methyl Red. Kelompok kajian telah dijalankan untuk menilai kesan pelbagai parameter: (masa, kepekatan permulaan, dos penjerap dan pH), kepada kapasiti penjerapan pewarna Metil Merah. Hasil kajian menunjukkan bahawa sabut kelapa mentah menyingkirkan metil merah pada kapasiti maksimum pada 40 minit sementara karbon diaktifkan pada 20 minit. Kedua-dua penjerap telah menyingkirkan pewarna pada kapasiti tertinggi ialah pada 20 mg/L dan pH 2. Sementara, dos yang digunakan adalah berbeza di mana sabut kelapa mentah pada 0.05g manakala karbon diaktifkan pada 0.1 g. Sabut Kelapa karbon diaktifkan telah didapati lebih berkesan daripada sabut kelapa mentah sebagai bahan penjerap dalam menyingkirkan pewarna Metil Merah di mana ia menyingkirkan 50% sehingga 80% manakala sabut kelapa mentah hanya menyingkirkan 40% hingga 60%.

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## CHAPTER 1

### INTRODUCTION

#### 1.1 Background of Study

Nowadays, pollution is a big concern to Earth. Pollution is making environment such as land water, air is dirty and unsafe or unsuitable to use. According to Pure Earth, there are about 200 million of people are affected by pollution. Life expectancy will reduce to 45 years because of cancer and another disease that causes pollution. One of the most serious pollution that contribute big problems of today's civilization is water pollution. Water pollution happens when toxic substances enter water bodies such as lakes, rivers, oceans and so on, getting dissolved in them, lying suspended in the water or depositing on the bed. This degrades the quality of water which is can give great impact to human, animal and water life.

Water pollution can cause aquatic life that depends on the water bodies where it can affect the food chain because of the dead of aquatic life. Moreover, it gives big impact to human where we use water for drinking and it provides food. People can get a disease such as hepatitis by eating food that comes from water that has affected to the pollution. The main causes of water pollution are logically often man made that caused by human activities and the increasing of industrialization. The water bodies are affected from industrial, sewage and waste water and agricultural waste and accidentally leaking, run off, dumping and disposal. The mostly activities that polluted the water is industrial activities because industries produce a large amount of waste which is containing toxic chemical and pollutants such as dyes, lead, mercury, nitrates, and others harmful pollutant. The improper waste management from the industries has causes the waste were drained to the river, canals and sea.

Dyes are broadly used in diverse industries, such as leather, plastics, textiles, cosmetics, and paper which are mostly derived from azo dyes (Muthuraman & Teng, 2009 and Mahmoud *et al.*, 2009). Dyes is used because of their characteristics is bright in colour, easily water soluble, inexpensive and easy to apply (Carmen & Daniela, 2012) for colouring their product and it is widely used in textiles industries such as in Malaysia, they used it for batik. Excessive usage of dye can contribute to the water pollution during the dyeing process where 50% of the dye was lost in wastewater because of the low levels of dye-fibre fixation (Adegoke & Bello, 2015 and Salleh *et al.* 2011). There are about 100 000 dyes exist and every year more than 700 000 tons of dyes are produced (Kyzas & Kostoglou, 2014). Dye give harmful effect to human where it can cause ill effect such as cancer, skin irritation and allergy.

There are several methods that have been introduced to remove pollutants including dye such as physical, chemical and biological. There are various method that can be used to remove dyes from wastewater which are coagulation, membrane filtration, chemical precipitation (Anirudhan & Sreekumari, 2011), photocatalytic degradation, ozone treatment (Muthuraman & Teng, 2009), sedimentation, adsorption (Etim *et al.*, 2013) and etc.

Adsorption method is commonly used in removing contaminants in water including dyes and it is an effective method (Chaudhuri *et al.*, 2009). It is because of its speciality where it is efficient in removal pollutants and dyes (Kyzas & Kostoglou, 2014). Dye adsorption is a process of transferring the dye molecules from bulk solution phase to the surface of the adsorbent. The activated carbon that is used in adsorption process is effective but it is highly cost because it needs the regeneration after each sorption cycle (Pirbazari *et al.*, 2014). There are many research for replacing the activated carbon to remove dye where it is inexpensive and effective alternative which

is usage of agriculture waste for adsorption such as tamarind seed (Phatai *et al.*, 2014), coconut coir (Chaudhuri *et al.*, 2012), durian seed (Mohd *et al.*, 2015), rice husk, fruit peel (Santhi *et al.*, 2010) and etc.

The standard calibration curve must be plotted in order for us to determine the unknown concentration of pollutants in wastewater. A set of calibration standard concentration will be used to determine the range of values that lies to detect the concentration of certain samples. If the range of absorbance for the unknown solution is in the range of the calibration standard solution absorbance we can predict the unknown concentration value (Tahir *et al.*, 2008).

## **1.2 Problem Statement**

Increasing of usage dye in some industries and mostly from textile industry has shown the increasing of pollution in water and it is severe problems of worldwide. There are many dyes that used by industries and one of them is methyl red that will be used in this study. Methyl red can cause eye and skin sensitization or digestive tract irritation of it is inhaled or swallowed. The cost of removal dye from wastewater is expensive because of it highly variable in composition.

There are many methods have been studied to remove dyes from wastewater such as adsorption, sedimentation and etc. Adsorption is one of the method that used to remove dye from wastewater where it is effective but it is highly in cost. To reducing the cost, there are many studies using agriculture waste as activated carbon and it is more effective because it can use repeatedly. Agricultural waste that used as activated carbon is coconut coir that will be used in this study to remove methyl red as an adsorbent.

Coconut coir can be considered as agricultural waste because mostly, coconut companies take the oil or the water from the coconut, so they normally incinerated or dumped it without control. There are about 80% of the coconut were discarded as waste. Coconut coir will be used in this study because it is renewable, available in a large amount, less expensive and easily found as Malaysia is a tropical country. Coconut coir is rich with lignins and tannins where it can act as potential pollutant absorber. Coconut coir is produced when the fibre from coconut husk is shredded and it is 70% of coconut husk.

### **1.3 Objectives**

This study is to achieve the following objectives:

1. To optimize the effect of contact time, initial concentration, adsorbent dosage and pH of the raw and activated carbon of coconut coir as an adsorbent to remove the methyl red dye.
2. To determine the efficiency of raw and activated carbon of coconut coir in removing methyl red dye.

### **1.4 Significance of Study**

Significance of this study is to introduce the inexpensive and efficient adsorbent from agricultural waste where it can reduce the cost of water treatment. This study also can help to minimize the impact of the dye to human and environment. The result of these study can be used as a guideline for further study in producing the new inexpensive and more efficient adsorbent for treatment of dye waste.

## CHAPTER 2

### LITERATURE REVIEW

#### 2.1 Water Pollution by Textile Industry

Water is one of major importance to all living things where up to 90% of the body weight of some organisms comes from water. Moreover, up to 60% of the human body is water, the brain is composed of 70% water, the lung are nearly 90% water and about 83% of our blood is water. This shows how importance the water to our lives. However, water pollution is the biggest problem in any part of the world and three-fourth of the world were covered by water. One of the largest consumer to water pollution is textile industry because it requires a great amount of two components which are chemical and water. There are about 8000 chemical that were used in this industry where the chemical are poisonous and give severely effect to human health either directly or indirectly (Rita, 2012). Furthermore, there are about 1.6 million liters of water were needed for an average size of textile mill for dyeing, printing and washing (Rita, 2012). There are about 50% of the dye used in the industry was lost in wastewater can results in numerous problems such as chemical oxygen demand (COD) by the water body and an increase in toxicity (Adegoke & Bello, 2015 and Mohammed *et al.*, 2014).

#### 2.2 Dyes

Dyes is a natural or synthetic substances that are used to put the colour or changing the colour of anything. Dyes are complex organic material so it is intended to be stable therefore, it is hard to breakdown. Dyes are broadly used in various industries that involved in production of consumer product such as textiles, leather, plastics, paper and cosmetics but it is usually produced from textiles industry because



they use it to colour their products (Muthuraman & Teng, 2009). Textile industry is responsible in using and discharge dyes about 1.3 million tonnes and pigments and mostly it is synthetic. Approximately, there are about 2% of dye were discharged right to the aqueous effluent and it is also lost during the colouring process which is about 10%. It is plausible that there are about 20% of dyes were enter to the environment (Arora, 2014)

Discharging of these dyes in water can give effects to human health, such as dysfunctions of kidneys, reproductive systems, liver, brain and nervous system when using the water to do their daily life activity such as washing, bathing, cooking and drinking. Moreover, it also affects the aquatic plant because they decreasing the transmission of light through water (Kharat, 2015 and Salleh *et al.*, 2011).

### 2.2.1 Classification of dyes

Dyes that used in textile industry have classified into 3 classes which are anionic, cationic and non-ionic. Dyes also can be classified based on their chemical constituents and application such as acid dyes, basic dyes, reactive dyes, direct dyes and disperse dyes (Kharat, 2015). Table 2.1 shows the typical characteristic of dyes used in textile industry

**Acid dyes:** are highly water soluble, and have better light fastness than basic dyes. The textile acid dye are effective for protein such as silk, wool, nylon and modified acrylic. Acid dyes are applied from a strongly acidic to neutral pH bath. Moreover, these dyes combine with the fiber by hydrogen bonds, Van der Waals forces or through ionic linkages. The dyes are normally very complex in structure but have large aromatic molecules, having a sulphonyl or amino group which makes them

soluble in water. There are three main molecule structure which are anthraquinon, azo dye, and triphenylmethane types (Noridah, 2010).

**Basic dyes:** is cationic dyes. This a class of synthetic dyes, that act as bases and when made soluble in water, they form a coloured cationic salt, which can react with the anionic sites on the surface of the substrate. The basic dyes produce bright shades with high tinctorial values, on textile materials. The basic dyes react on the basic side of the isoelectric points. Basic dyes are salts, usually chlorides, in which the dyestuff is the basic or positive radical. Basic dyes are powerful colouring agents. It's applied to wool, silk, cotton and modified acrylic fibres (Noridah, 2010).

**Reactive dyes:** generally used for cotton and other cellulosics, but are also used to a small extent on wool and nylon. These dyes form a covalent bond with the fiber and contain chromophoric groups such as azo, anthraquinone, triarylmethane, phthalocyanine, formazan, oxazine, etc. Their chemical structures are simpler, absorption spectra show narrower absorption bands, and the dyeings are brighter making them advantageous over direct dyes (Noridah, 2010).

**Table 2.1:** Typical characteristic of dyes used in textile industry (Noridah, 2010)

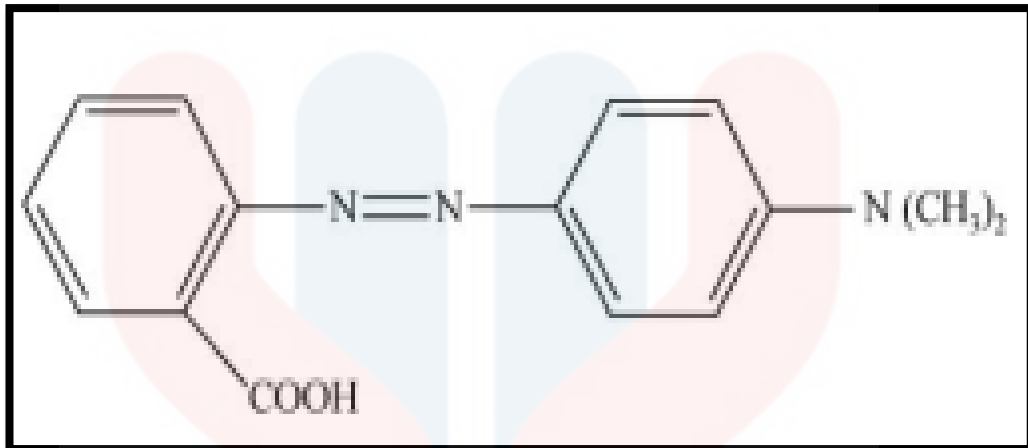
<b>Dye class</b>	<b>Description</b>	<b>Fibres typically applied to</b>	<b>Typical pollutant associated with various dyes</b>
Acid	Water-soluble anionic compounds	Wool, nylon	Colour, organic acids, unfixed dyes
Basic	Water-soluble, applied in weakly acidic dye baths, very bright dyes	Acrylic, some polyesters	N/A
Direct	Water-soluble, anionic compounds can be applied directly to cellulosic without mordant (or metals like chromium and copper)	Cotton, rayon, other cellulosic	Colour, salt, unfixed dye, cationic fising agents, surfactant, defoamer, levelling and retarding agents, finish, diluents
Disperse	Not water-soluble	Polyester acetate other synthetics	Colour, organic acids, phosphate, carriers, levelling, defoamers, lubricants, diluents
Reactive	Water-soluble, anionic compounds, largest dyes class	Cotton, other cellulosic, wool	Colour, salt, alkali, unfixed dye, surfactant, defoamer, diluents, finish
Sulfur	Organic compounds containing sulphur or sodium sulphide	Cotton, other cellulosic	Colour, alkali, oxidizing agents, reducing agent, unfixed dye
Vat	Oldest dyes, more chemically complex, water insoluble	Cotton, other cellulosic	Colour, alkali, oxidizing agent, reducing agent

**Direct dyes:** used in the dyeing of cotton and rayon, paper, leather, and, to some extent to nylon. They are water-soluble anionic dyes, and, when dyed from aqueous solution in the presence of electrolytes have high affinity for cellulosic fibres. Generally the dyes in this class are polyazo compounds, along with some stilbenes, phthalocyanines and oxazines (Noridah, 2010).

**Disperse dyes:** A class of slightly water-soluble dyes originally introduced for dyeing acetate and usually applied from fine aqueous suspensions. Disperse dyes are widely used for dyeing most of the manufactured fibres. Disperse dyes have substantivity for one or more hydrophobic fibres e.g. cellulose acetate, nylon, polyester, acrylic and other synthetic fibres (Noridah, 2010).

### 2.2.2 Methyl Red

Methyl red (2-(N,N-dimethyl-4-aminophenyl) azobenzenecarboxylic acid), also called C.I. Acid Red 2, that will turn red in acidic solution as an indicator dye. Methyl red is powder in dark red colour and it is an anionic azo dye (Noridah, 2010). Methyl red is well known used in paper printing and textile dyeing. Methyl red can causes irritation of the eye, skin and digestive tract if it is inhaled or swallowed (Muthuraman & Teng, 2009). Figure 2.1 shows the structure of Methyl Red.



**Figure 2.1:** Structure of Methyl Red, (Muthuraman & Teng, 2009).

### 2.3 Adsorption

The adsorption process is known with its simple design and easy to operate. It is inexpensive compare to another process such as chemical treatment where it treats of dye wastewater with coagulating or flocculating agent in removing the colour of dye. This process is expensive due to the cost of chemicals because it involves adding agents such as aluminium or calcium to the dye effluent and induces flocculation (Noridah, 2010).

The adsorption technique is effective in removing metallic pollutants and dyes from wastewater. Activated carbon is broadly used as adsorbent in the treatment process as it have high specific porosity and high surface area (Sivakumar *et al.*, 2012). Activated carbon is charcoal that has been heated or otherwise treated to increase its adsorptive power. The usage of activated carbon is limited because it is high cost because of the needing regeneration after each sorption cycle (Sharma *et al.*, 2009). To achieve activated carbon with highest adsorption capacity, they can be performed by physical or chemical method or a combination of both (Sivakumar *et al.*, 2012).

### 2.3.1 Physical Activation

Physical activation is involving two steps process that starts with the carbonization of the materials followed by the activation of the resulting char in an inert atmosphere or in the presence of carbon gasification reactant (gaseous) such as carbon dioxide, steam or air or a suitable combination of the above mentioned gaseous activating agents (Billy *et al.*, 2013 and Viswanathan *et al.*, 2009). The carbonization can be carried out using tubular furnace, muffle furnace, reactors, and more recently in glass reactor placed in a modified microwave oven (Virginia *et al.*, 2012).

### 2.3.2 Chemical Activation

Chemical activation is involving only one step process in preparing the activated carbon which is it involves the impregnation of materials in presence of chemical agents such as Zinc Chloride ( $ZnCl_2$ ), Potassium Hydroxide (KOH), Hydrochloric Acid (HCl), Sulphuric Acid ( $H_2SO_4$ ) and Sodium Hydroxide (NaOH) (Billy *et al.*, 2013 and Viswanathan *et al.*, 2009). Usually chemical activation is more preferable than physical activation as it faster process with a lower activation temperature. Furthermore, the activated carbon produced via chemical activation have good pore development, high carbon yield and high specific surface area (Hui & Muhammad Abbas, 2015).

### 2.3.3 Advantages and Disadvantages of Physical and Chemical Activation

Activated carbon is a carbon which have been subjected to a physical or chemical activation. These two process presents several advantages and disadvantages as shown in Table 2.2 (Bachrun *et al.*, 2016 and Virginia *et al.*, 2012).

**Table 2.2:** Advantages and Disadvantages of Physical and Chemical Activation.

Physical Activation	Chemical Activation
<p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• The process is not corrosive</li> <li>• A washing stage is not required</li> <li>• Cheaper</li> <li>• Avoids the incorporation of impurities coming from the activating agent</li> </ul>	<p><b>Advantages</b></p> <ul style="list-style-type: none"> <li>• Single step activation</li> <li>• Low activation temperatures</li> <li>• Low activation time</li> <li>• Higher yields</li> <li>• Better porous structure.</li> </ul>
<p><b>Disadvantages</b></p> <ul style="list-style-type: none"> <li>• Obtained with two steps activation</li> <li>• Long activation time</li> <li>• Narrow pore distribution</li> <li>• Low yield of the activated carbon</li> <li>• High temperature of activation</li> </ul>	<p><b>Disadvantaged</b></p> <ul style="list-style-type: none"> <li>• Inorganic impurities</li> <li>• Corrosiveness of the process</li> <li>• Expensive</li> <li>• The process involves a complex recovery and recycle of the activating agent, which generates liquid discharge that demands effluent treatment.</li> </ul>

## 2.4 Adsorbent

There are many researcher have studied the availability of removing dye from wastewater using low cost adsorbent such as coconut husk and shell, rice husk, orange peel, banana peel, saw dust etc. as shown in Table 2.3.

### 2.4.1 Coconut Coir

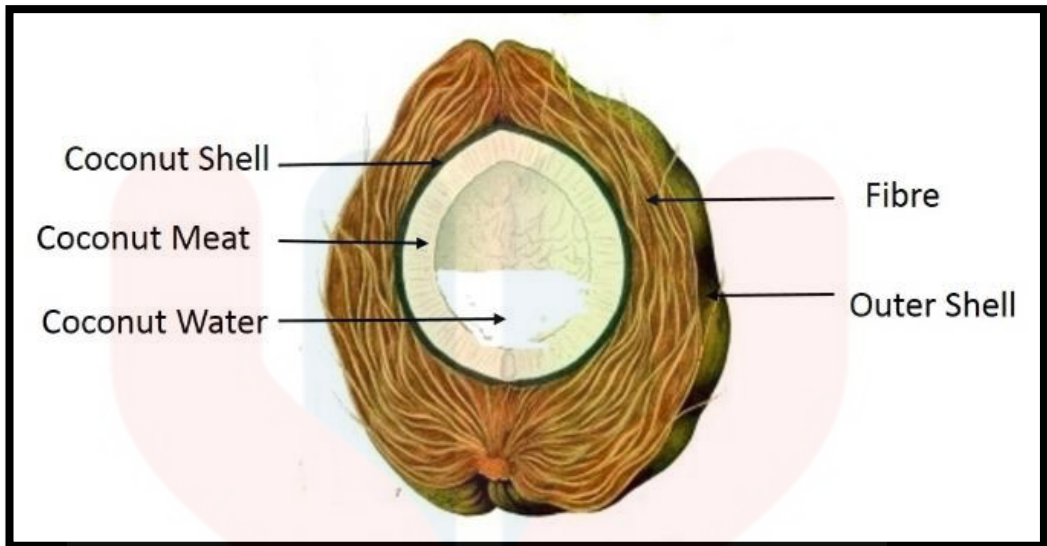
The adsorbent used, coconut (*Cocos nucifera L.*) is easily found in Malaysia because it is a tropical country. Coconut coir or also known as coconut fiber is obtained from the outer shell (endocarp) or the husk of coconut which is the seed-hair fibre (Khedari *et al.*, 2003). Coconut coir is the natural fiber of the coconut husk which it is dense and rough yet it is durable as shown in Figure 2.2. Coconut coir dust is described as brown, spongy particle of low weight which falls out when the fibre is shredded from the husk as shown in Figure 2.3. The coir dust is about 70% from the weight of the coconut husk (Etim *et al.*, 2012). Coconut husk can be carbonized much more efficiently than coconut shell because of their flammability. Coconut husk proved to be useful combustion medium to improve the carbonization of the coconut shells (Cobb *et al.*, 2012). Table 2.4 shows the chemical composition of coconut coir.

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**Table 2.3:** Some Low Cost Material for Dye Removal from Aqueous Solution  
(Faradilla, 2006)

Adsorbent(s)	Dye(s)
Bamboo dust, coconut shell, groundnut shell, rice husk	Methylene blue
Silk cotton hull, coconut tree sawdust, sago waste, maize cob	Silk cotton hull, coconut tree sawdust, sago waste, maize cob
<i>Parthenium Hysterophorus</i>	Methylene blue, malachite green
Rice husk	Malachite green
Coir pith	Acid violet, acid brilliant blue, methylene blue, Rhodamine-B
Orange peel	Acid violet 17, Congo red, Rhodamine-B, procion orange
Banana and orange peels	Methyl orange, methylene blue, Rhodamine-B, congo red, methyl violet, acid black 10B
Banana pith	Congo red, Rhodamine-B, acid violet, acid brilliant blue.
Carbonized coir pith	Acid violet, Rhodamine-B
Hardwood	Astrozone blue
Chitosan	Acid blue 25, basic blue 69
Mahogany sawdust, rice husk	Acid yellow 36
Plum kernels	Basic red 22, acid blue 25
Rice husk	Safranine, methylene blue



**Figure 2.2:** The part of coconut



**Figure 2.3:** Coconut Coir Fiber

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**Table 2.4:** Chemical composition of Coconut Coir

Lignin	45.84%
Cellulose	43.44%
Hemi-cellulose	0.25%
Pectin's and related Compound	3.00%
Water soluble	5.25%
Ash	2.22%

In 2012, Shen and their team researchers studied on removal of hexavalent Cr by coconut coir and derived chars. The various pyrolysis temperature on removing Cr (VI) by coconut coir and chars were evaluated. Increasing pyrolysis temperature were effect the increasing of surface area of chars and decreased in the corresponding content of oxygen-containing functional groups. Coconut coir and coconut coir-derived chars were attributed in reduction of Cr (IV) to Cr (III) and the oxygen-containing functional group was resulted in reduction of rate Cr (IV).

Etim *et al.*, (2013) have studied on dye removal from aqueous solution using coconut coir dust extract-modified polyvinyl alcohol. The cross linking of polyvinyl alcohol having –OH group on its molecule with coconut coir dust was investigated. The application of the adsorbent in removing cationic malachite green was studied. The adsorption was studied as function of solution pH, contact time and initial dye concentration. The effect of adsorbent dosage on the removal malachite green was investigated with different adsorbent dosage (1.0 – 4.0 mg) in 100 mL dye solution, the pH effect is in range 1.0 – 10.0.

Chaudhuri *et al.*, (2012) studies is on using coconut coir activated carbon as an adsorbent for removal of textile acid azo dye from aqueous solution. Their objective is preparing an adsorbent from agricultural waste and test its effectiveness in removing the Acid Red 18 and Acid Orange 7 from aqueous solution. Contact of time, pH and carbon dosage were evaluated. The maximum adsorption were occurred at pH 3 and in 2h. In their results has shown that adsorption capacity of coconut coir activated carbon was higher that the commercial activated carbon which it is 76-81%.

Gupta *et al.*, (2011) studied on removal of hexavalent chromium using activated coconut shell and activated coconut coir as low cost adsorbent. The studies

was conducted to determine the efficiency of removal toxic hexavalent chromium. The effect of pH, adsorbent dose, contact time and initial metal ion concentration have been studied. The result was shown that activated coconut shell was more efficiency than activated coconut coir. The maximum removal by activated coconut shell was 88% and 83.0% for 0.3 mm and 1.0 mm. The optimized condition of the experiment were at pH 2, 1.0 g of 100 ml adsorbent dosage, 60 minutes and 10 ppm of initial concentration.

Taimur *et al.*, (2010) have studied on adsorptive removal of reactive yellow 15 from aqueous solution by coconut coir activated carbon. In their studies, the adsorption capacity of coconut coir activated carbon (CCAC) and compared with commercial activated carbon (CAC) to access the suitability as a cost-effective substitute for commercial activated carbon. Initial dye concentration, contact time and the pH value of the solution were evaluated. It shows that the equilibrium adsorption were attained within 240 min, at maximum adsorption occurring at pH 2. The equilibrium data for both activated carbon were described by Langmuir and Freundlich isotherm model and have indicated the higher capacity adsorption of CCAC. The results indicate that CCAC is more effective than CAC for the adsorption of RY15 and it shows that it would be more suitable substitute for CAC in the removal of Reactive dyes from aqueous solution.

Sharma *et al.*, (2009) have studied on removal of a cationic dye from wastewater by adsorption on activated carbon developed from coconut coir. In their studies, the coconut coir has been developed by thermal activation. The effect of temperature and contact time have been studied. Their results have shown the cationic dye was removed and it is increased from 74.20 to 93.58% at 30°C, 150 rpm, and at pH 5.3.

## 2.5 UV-Vis Spectrophotometer

Ultraviolet-Visible Spectrophotometer or also known as UV-Vis or UV/Vis is referring to the adsorption spectroscopy or reflectance spectroscopy in the ultraviolet spectral region. UV-Vis used the light in the visible and adjacent which is it is near-UV and near-infrared (NIR) ranges. UV-Vis normally used in analytical chemistry for the quantitative determination of different analytes, such as transition metal ions, highly conjugated organic compounds, and biological macromolecules. The concentration of an analyte in solution can be determined by measuring the absorbance at a single wavelength. The concentration of an absorbing analyte solution is linearly related to the absorbance. Wavelength scan is first performed with the reference solution and the wavelength corresponds the maximum absorbance value is found to be used to get more precise absorbance data.

The calibration curved that used in analytical chemistry is a method to determine the concentration of a substance in an unknown sample by comparing the unknown to a set of standards sample of known concentration. The calibration curve provides a reliable way to calculate the uncertainty of the concentration calculated from the calibration curve (using the statistics of the least squares line fit to the data).

## CHAPTER 3

### MATERIAL AND METHODS

#### 3.1 Materials

The materials that were used in this study are Methyl Red dye, 0.1M of HCl, 0.1M of NaOH and distilled water.

#### 3.2 Apparatus and Instruments

The apparatus that were involved in this study are micro pipette (1000  $\mu$ L) (Watson Nexty, Japan), dropper, beaker (Schott Duran, Germany), volumetric flask, measuring cylinder, crucible, conical flask (Schott Duran, Germany), filter paper, pH indicator, sieve (2.0mm) (Impact, UK), aluminium foil (USA) and glass rod. Instrument that is involved in this study are Ultra Violet-Visible Spectrophotometer, orbital shaker (SI-600R) (AZ-Tech Sinar, Pulau Pinang), grinder, oven, muffle furnace, vacuum pump, hot plate, blender (ELBA, Italy), electronic weighing balance (Cimarec, China) and pH meter.

#### 3.3 Preparation of Raw Material of Coconut Coir

Coconut coir was collected from coconut shop at Jeli, Kelantan. The collected coconut coir was washed to remove the dirt and sand particles, then it was dried in sunlight for 48 hours. After have been dried, the coconut coir was grinded and sieved to get 0.4 mm of particle size. Then, the raw material of coconut coir (CC) was kept in a plastic container for further used.

#### 3.4 Preparation of Coconut Coir Activated Carbon

The collected coconut coir was washed and dried for 48 hours. Then, the dried coconut coir was grinded and sieved to 0.4 mm and carbonized in tubular muffle

furnace for 60 minutes at 270 °C for carbonization. After 60 minutes, the coconut coir was washed with distilled water to make the pH near neutral and it was dried in oven for 24 hours at 105 °C. After 24 hours, the coconut coir activated carbon (CCAC) was kept in a plastic container for further used (Gupta *et al.*, 2011).

### **3.5 Preparation of Methyl Red Dye Solution**

1.0 g of Methyl Red dye was dissolved in 1000 mL of distilled water to prepare a stock solution of 1000 mg/L of dye (Hassan & Abdulhussein, 2015). Different concentration ranged in between 10 and 50 mg/L of Methyl Red dye solution was prepared from the stock solution. The initial pH was adjusted with 0.1 M HCl or 0.1 M NaOH (Santhi *et al.*, 2010).

### **3.6 Preparation of blank solution**

50 mL of Methyl red solution was put in conical flask without putting adsorbent and adjusted the pH and initial concentration. The solution was analysed using UV-Vis Spectrophotometer to determine the absorbance value. Then, the value was a control for this experiment.

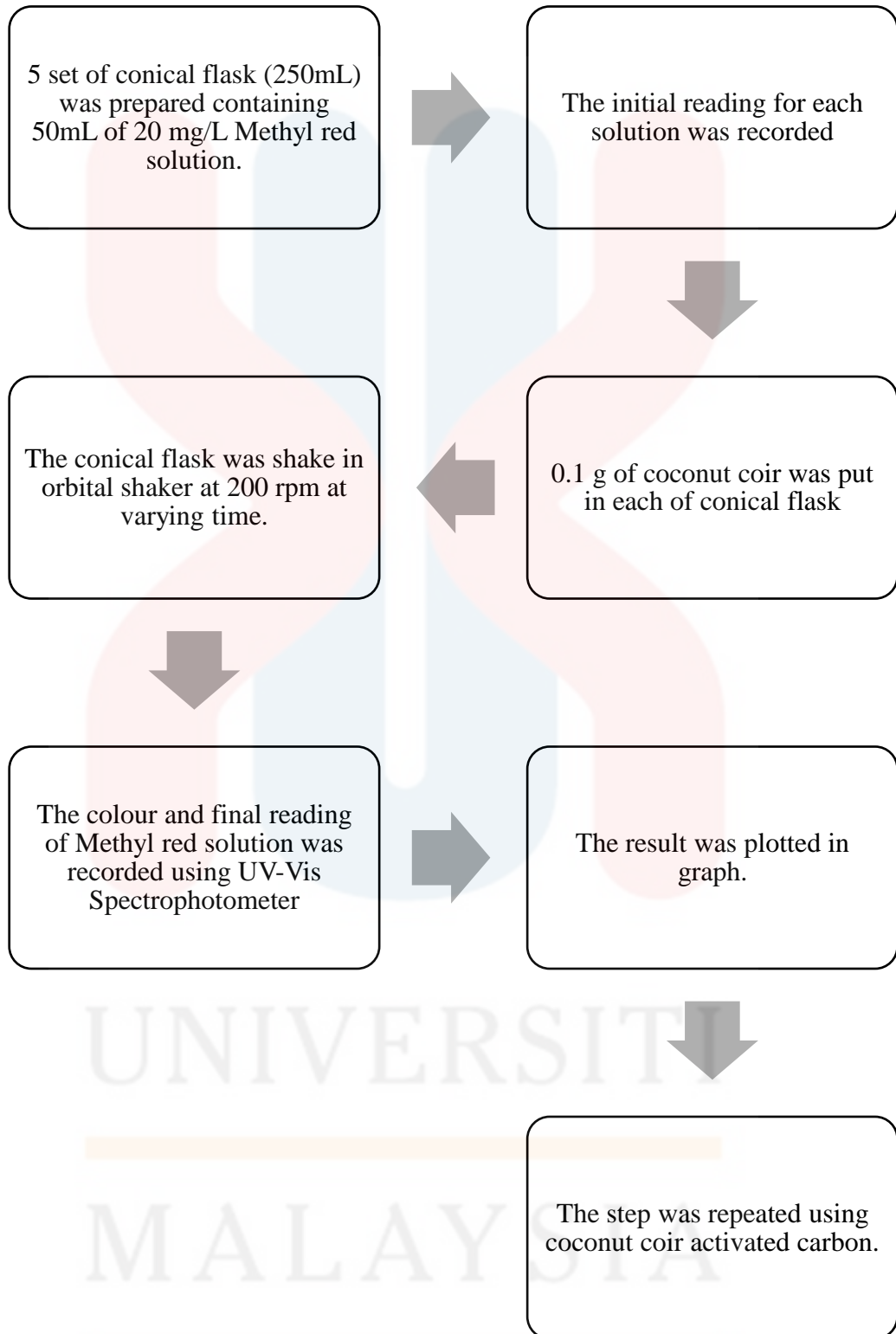


### 3.7 Adsorption Test

Batch adsorption experiments will be carried out in 100 mL flasks and the total volume of the reaction solution will be kept at 50 mL.

#### 3.7.1 Effect of contact time

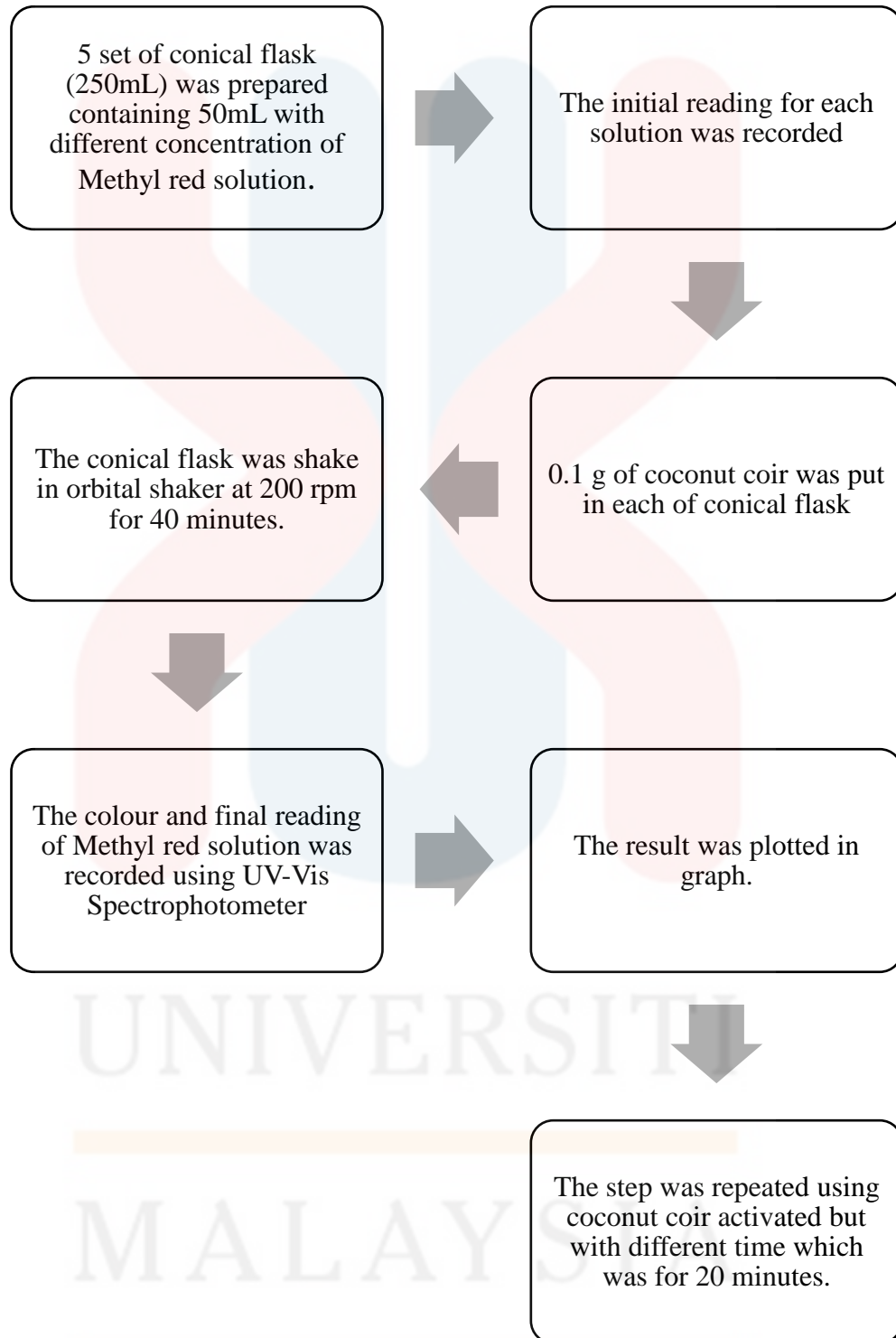
50 mL of the Methyl Red solution was put in each different conical flask. The initial reading of each conical flask was recorded. 0.1 g of coconut coir was put in all conical flask and each of it will be shake at surrounding temperature in orbital shaker at 200 rpm. The time will be varying at 0, 10, 20, 30, 40, 50 and 60 minutes. Then, the flasks was withdrawn from the shaker, the solution was filtered and the absorbance of the solution was measured and recorded. The result was plotted in a graph with percentage removal (%*R*) vs contact time. The experiment was repeated with coconut coir activated carbon. Figure 3.1 shows the flowchart of effect of contact time.



**Figure 3.1:** Flowchart of effect of contact time.

### 3.7.2 Effect of initial concentration

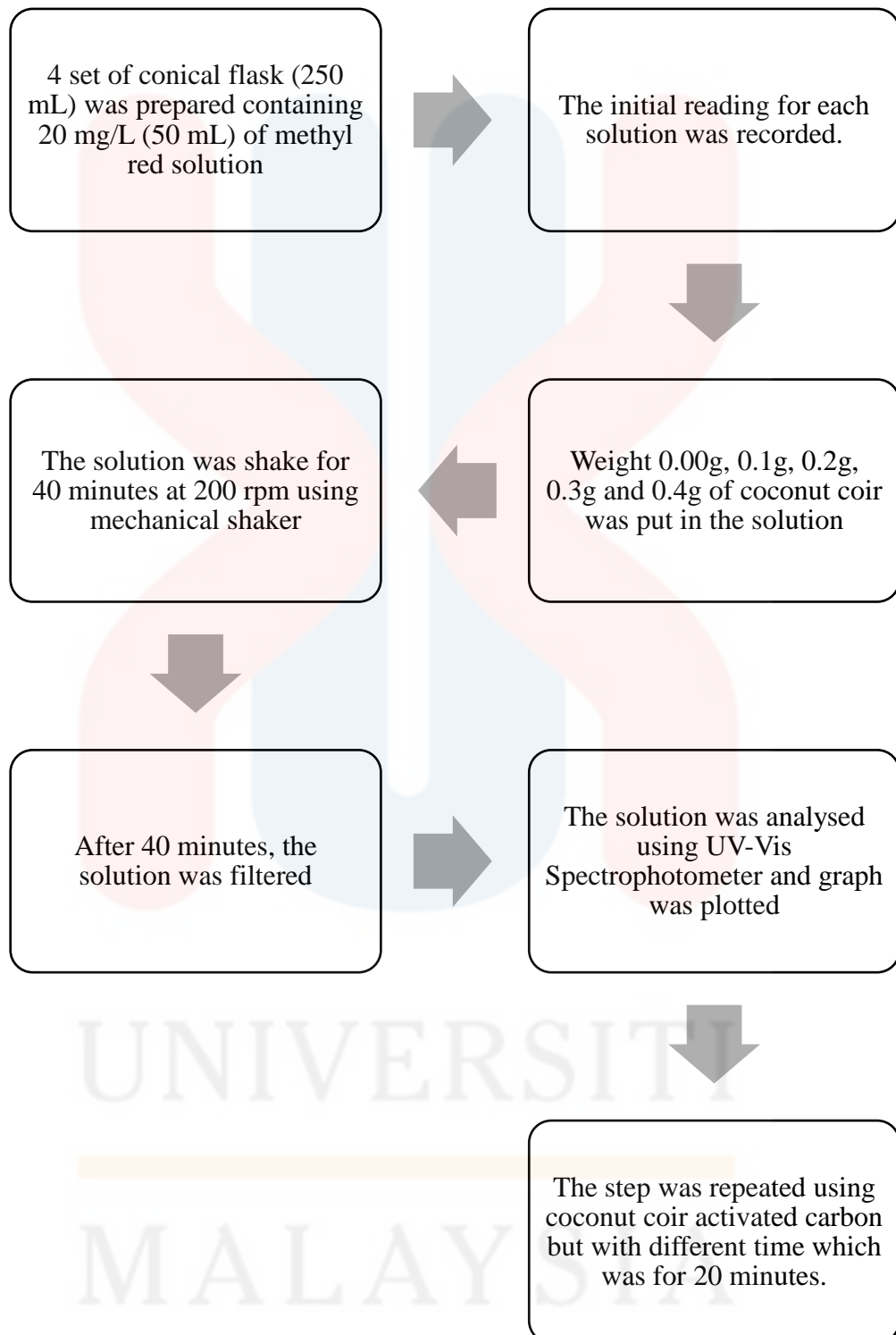
50 mL of the Methyl Red solution was put in each different conical flask. Then, the initial concentration of solution will be different to 0 mg/L, 10 mg/L, 20 mg/L, 30 mg/L, 40 mg/L and 50 mg/L. The initial reading of each conical flask was recorded. 0.1 g of coconut coir was put in all conical flask and each of it will be shake at surrounding temperature in orbital shaker at 200 rpm for 40 minutes. After 40 minutes, the solution was filtered and the absorbance was measured and recorded. A graph was plotted with (%R) vs initial concentration. The steps were repeated using coconut coir activated carbon with different time which was for 20 minutes. Figure 3.2 shows the flowchart of effect of initial concentration.



**Figure 3.2:** Flowchart of effect of initial concentration

### 3.7.3 Effect of adsorbent dosage

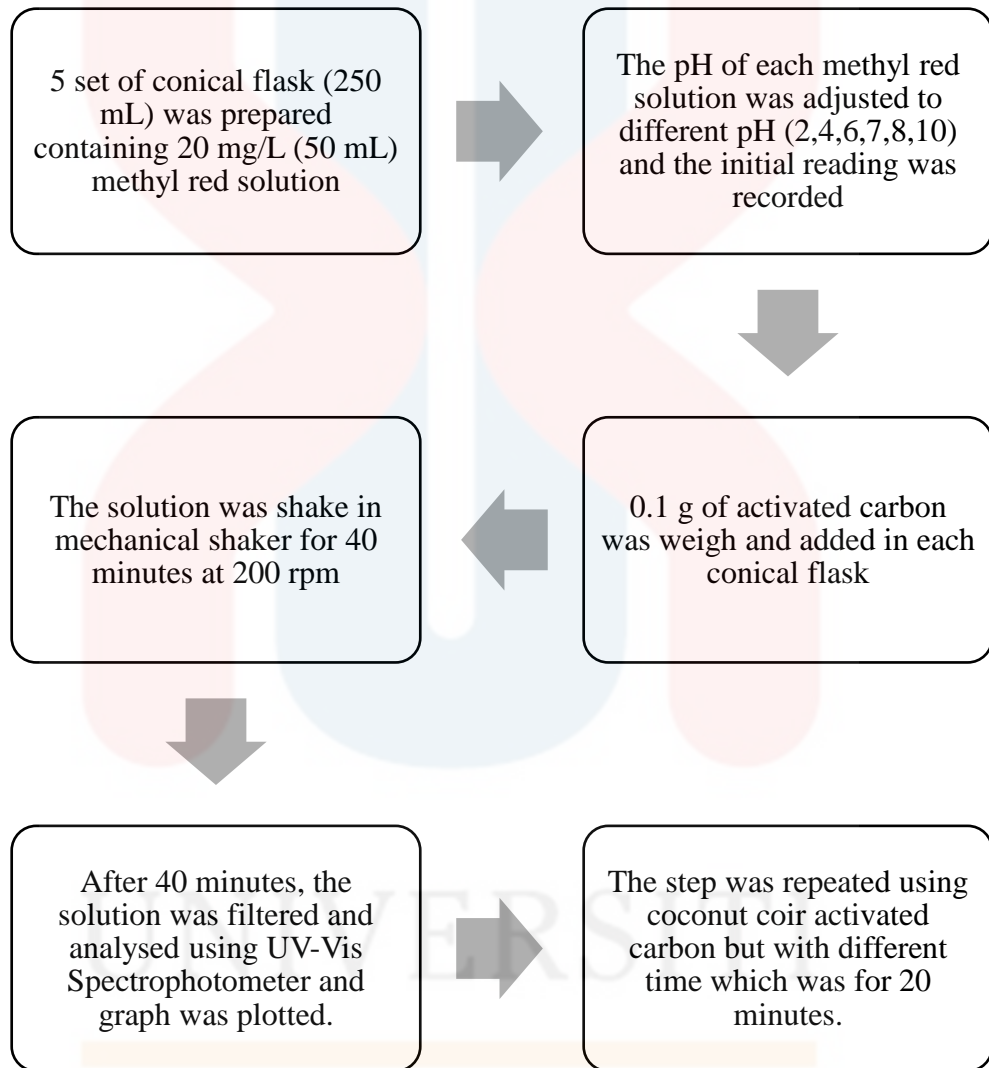
50 mL of Methyl Red solution was put in each different conical flask. Each conical flask was put with different dosage of coconut coir (0.0g, 0.1g, 0.2g, 0.3g and 0.4g). The solution was shake in orbital shaker at surrounding temperature for 40 minutes. Then, the solution was filtered and the absorbance was measured. A graph was plotted with (%*R*) vs adsorbent dosage. The experiment was repeated with coconut coir activated carbon. The steps were repeated using coconut coir activated carbon with different time which was for 20 minutes. Figure 3.3 shows the flowchart of effect of adsorbent dosage.



**Figure 3.3:** Flowchart of effect of adsorbent dosage

### 3.7.4 Effect of pH

50 mL of Methyl Red solution was put in each different conical flask. The pH of solution was adjusted at pH 2.0 until 10.0 using 0.1 M HCl or 0.1 NaOH. The solution was put with 0.1 g of coconut coir and was shake in orbital shaker at 200 rpm at surrounding temperature for 40 minutes. Then, the solution was filtered and the absorbance of the solution was measured. A graph was plotted with (%R) vs pH. The experiment was repeated with coconut coir activated carbon with different time which was for 20 minutes. Figure 3.4 shows the flowchart of effect of pH.



**Figure 3.4:** Flowchart of effect of pH



### 3.8 Preparation of calibration standard

The 10 mL of Methyl red solution from 1000 mg/L was transferred into 100 mL of volumetric flask and added with distilled water till the volume reach 100 mL line of the flask to prepare 100 mg/L of Methyl red solution. The volumetric flask was shaken to dissolve the solution evenly. The 100 mL of 100mg/L of Methyl red solution was used to prepare the subsequent solutions for calibration purpose. Using the dilution equation formula, the volume of solution to be taken from 100 mL of 100 mg/L solution was calculated for all the 5 calibration standard which are 2 mg/L, 4 mg/L, 6 mg/L, 8 mg/L and 10 mg/L. A 50 mL volumetric flask was added with 1 ml of prepared methyl red solution and volume to make 2 mg/L solution. The step was repeated to prepare the other 4 calibration standard solution each with different concentration. The calibration standard solution was analysed for their absorbance value using UV-Vis Spectrophotometer. The corresponding absorbance values was recorded.

The dilution equation formula is given as Equation 3.1:

$$m_1 v_1 = m_2 v_2 \quad (3.1)$$

Where,  $m_1$  and  $m_2$  are initial and final concentration, while  $v_1$  and  $v_2$  are initial and final volume of the solution.

### 3.9 Analysis using UV-Vis Spectrophotometer

All of the sample was analysed using a UV– Visible Spectrophotometer by monitoring the absorbance changes at  $\lambda$  max 410 nm. The wavelength was set up at 410nm. First of all, solution for calibration standard was tested to plot the calibration curve. The cuvette was filled up with 1.5 mL of the distilled water and was wiped to make sure there will be no any finger print. The protective cover was opened and put

the cuvette inside the UV-Vis Spectrophotometer. The transparent side of the cuvette was inserted parallel with the arrow. Then, the lid was closed and clicked zero on the UV-Vis Spectrophotometer. Next, the cuvette was filled with 2mg/L of the calibration standard solution and was wiped and put inside the UV-Vis Spectrophotometer and the value was recorded. The step was repeated with other 4 concentration. The calibration curve was plotted. After that, all the sample was analysed and the reading was recorded. The graph was plotted based on the absorbance value.

The adsorption of the methyl red dye was calculated using the following general formula (Hassan & Abdulhussein, 2015; Santhi *et al.*, 2010; Etim *et al.*, 2012 and Subhrajyoti, 2010) Equation 3.2:

$$q_e = \frac{V}{m} (C_o - C_e) \quad (3.2)$$

The percentage removal (R) was calculated using Equation 3.3:

$$\%R = \frac{C_o - C_e}{C_o} \times 100 \quad (3.3)$$

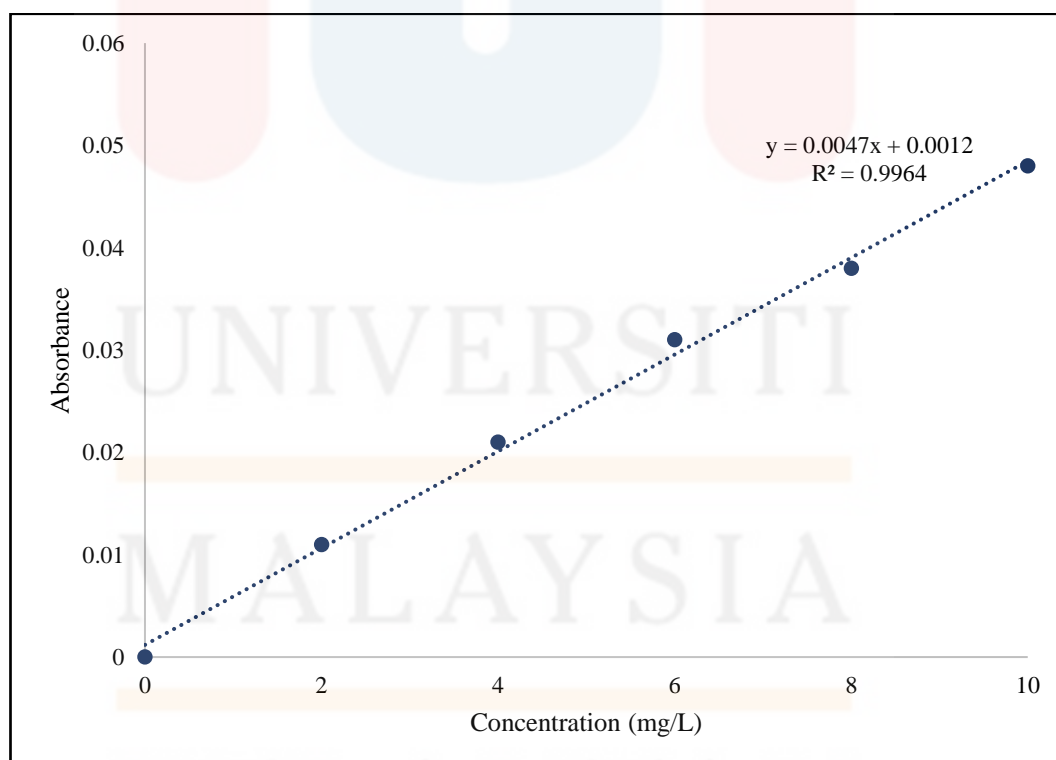
Where,  $C_0$  and  $C_e$  are the initial and equilibrium Methyl Red concentrations, respectively (mg/L),  $V$  is the Methyl Red solution volume (L),  $m$  is the mass of the adsorbent (g) (Etim *et al.*, 2012).

## CHAPTER 4

### RESULTS AND DISCUSSION

#### 4.1 Calibration Curve of Methyl Red

In this study, the unknown concentration of methyl red dye was determined by UV-Vis Spectrophotometer. The calibration standard that used for the calibration curve plotting was with 2 mg/L, 4 mg/L, 6 mg/L, 8 mg/L and 10 mg/L. Figure 4.1 shows the calibration curve of Methyl Red dye. The absorbance reading for all concentration were 0.011, 0.021, 0.031, 0.038, and 0.048. The equation for this calibration curve of Methyl Red dye was  $y = 0.0047x + 0.0012$  and the correlation coefficient,  $R^2$  was 0.9964 shows that the calibration curve was very close to the straight line. The nearer the value of  $R^2$  to 1, is the better.



**Figure 4.1:** The calibration curve for Methyl Red.

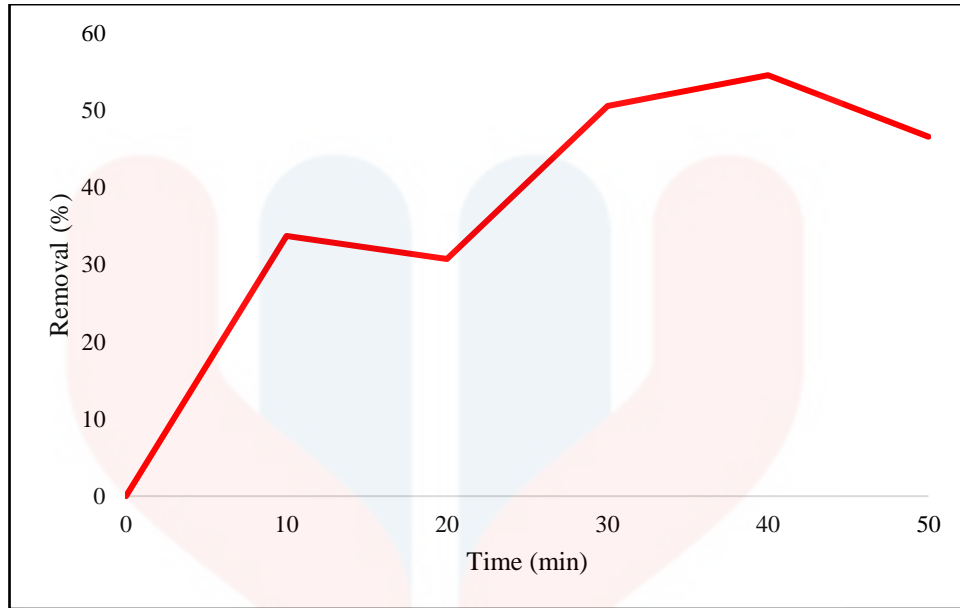
## 4.2 Adsorption Test for Coconut Coir

### 4.2.1 Effect of Contact Time

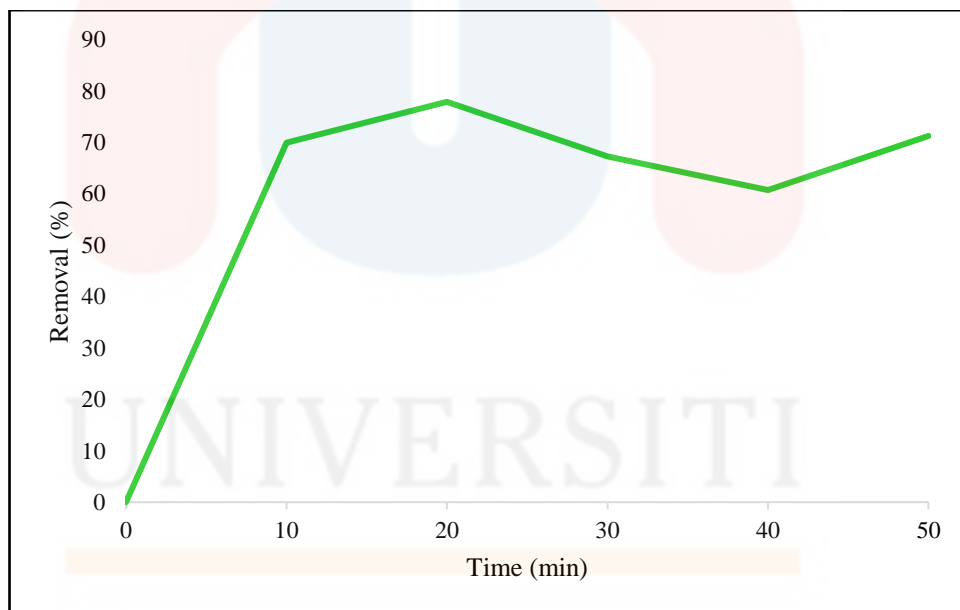
The effect of contact time on the adsorption of methyl red dye onto CC is performed at room temperature with 20 mg/L concentration, shaken at varying time at 200 rpm with 0.1 g of adsorbent. The result is illustrated in Figure 4.2. The result indicated that at the first 10 minutes of adsorption about 33.73% of the dye was removed and it was increased to its maximum which was 54.56% at 40 minutes of adsorption. Meanwhile, Figure 4.3 shows the effect of contact time on the adsorption of methyl red dye onto CCAC and was performed at same parameters. As the coconut coir was reached at its maximum adsorption at 40 minutes, the CCAC has removed 77.84% of dye at 20 minutes of adsorption.

Generally, when the contact time increased, the removal percentage also increase due to strong attractive forces between dye molecules and the adsorbent (Yamin *et al.*, 2007). After adsorption, the rate of dye uptake was controlled by the rate of transport of dye from the exterior to the interior sites of the adsorbent particles which were nearly constant throughout the period of time (Mohammed *et al.*, 2013). This trends similar in coconut coir dust as low cost adsorbent for the removal of cationic dye from aqueous solution (Etim *et al.*, 2012) where percentage removal was increased when the contact time also increased. However, in this study, only percentage removal in CC was increased as the contact time increased while the percentage removal of CCAC was decreased after reached its optimum at 20 minutes.

Based on the results, CCAC has removed 77.84% with 5.649 mg/g of adsorption capacity of methyl red dye while CC only removed 54.56% (5.266 mg/g) of methyl red dye. So, it shows that CCAC has higher efficiency than CC.



**Figure 4.2:** Effect of contact time on the adsorption of Methyl Red onto CC at room temperature; dosage = 0.1g; concentration = 20 mg/L; and stirring speed = 200 rpm.



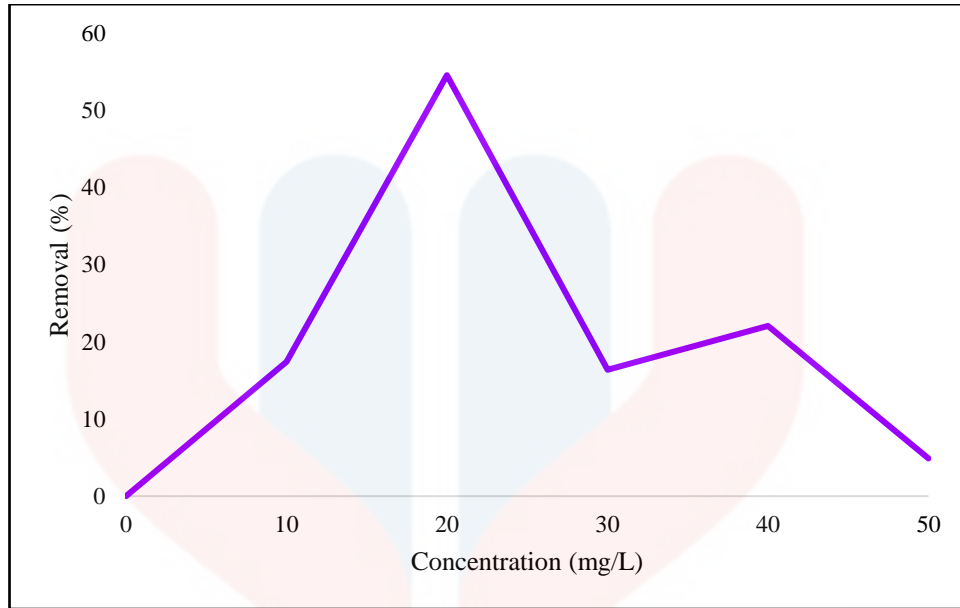
**Figure 4.3:** Effect of contact time on the adsorption of Methyl Red onto CCAC at room temperature; dosage = 0.1g; concentration = 20 mg/L; and stirring speed = 200 rpm.

#### 4.2.2 Effect of Initial Concentration

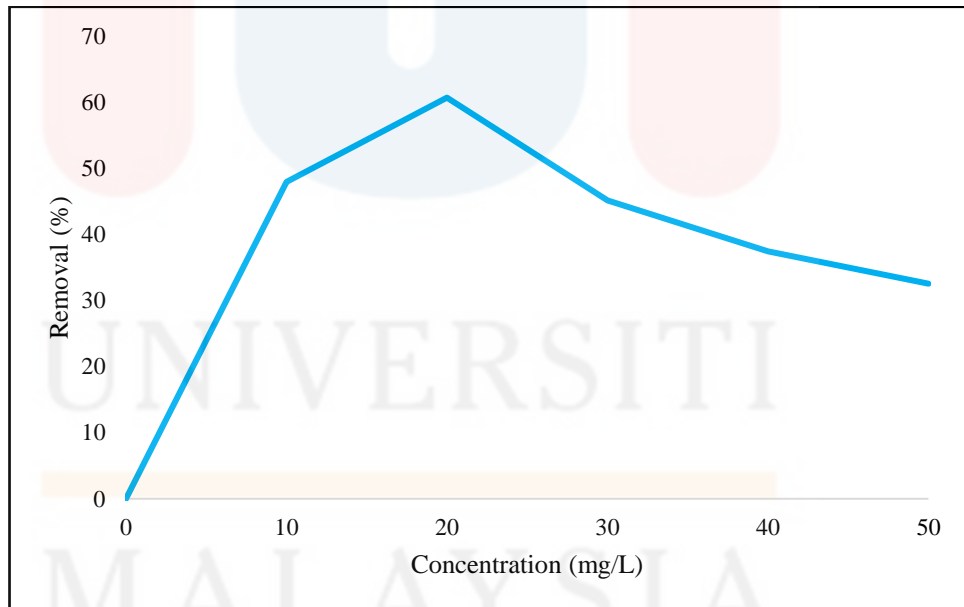
The effect of initial concentration of methyl red dye in the solution on the adsorption onto CC was studied and is shown in the Figure 4.4. The experiment was carried out at room temperature with different concentration and were shaken for 40 minutes with 0.1 g adsorbent dosage. Based on the graph shown, the percentage removal of methyl red dye is decrease as the initial concentration increase after reached the maximum adsorption at 20 mg/L with 54.56% (5.266 mg/g of adsorption capacity) of methyl red dye. Based on result that was illustrated in Figure 4.5 CCAC shows that the percentage removal of methyl red was greater at lower concentration and smaller at higher concentration where it has removed 60.69% (4.405 mg/g) of methyl red dye with the initial concentration was 20 mg/L. Similar result for removal of methyl red from aqueous solution by activated carbon prepared from the *Annona squamosa* seed by adsorption have been reported as the percentage removal was optimum at lower concentration (Santhi *et al.*, 2010).

The effect of initial dye concentration factor depends on the immediate relation between dye concentration and the available binding sites on the adsorbent surface (Etim *et al.*, 2012). The decreasing percentage of removal methyl red dye with an increase in initial dye concentration can be due to the saturation of adsorption sites on the adsorbent surface (Salleh *et al.*, 2011). As the concentration is low, there are uninhabited active sites on the surface of the adsorbent, and when the initial concentration increases, the active site required for the adsorption of the dye molecules cannot be found (Etim *et al.*, 2012). This shows the active sites in coconut coir shows the best interaction at lower concentration at 20 mg/L concentration of methyl red.

Based on the results, CCAC is more effective in removing methyl red dye than CC as activated carbon has more active site on the surface.



**Figure 4.4:** Effect of initial concentration on the adsorption of Methyl Red onto Coconut Coir at room temperature; dosage = 0.1g; time = 40 minutes; and stirring speed = 200 rpm.



**Figure 4.5:** Effect of initial concentration on the adsorption of Methyl Red onto CCAC at room temperature; dosage = 0.1g; time = 20 minutes; and stirring speed = 200 rpm.

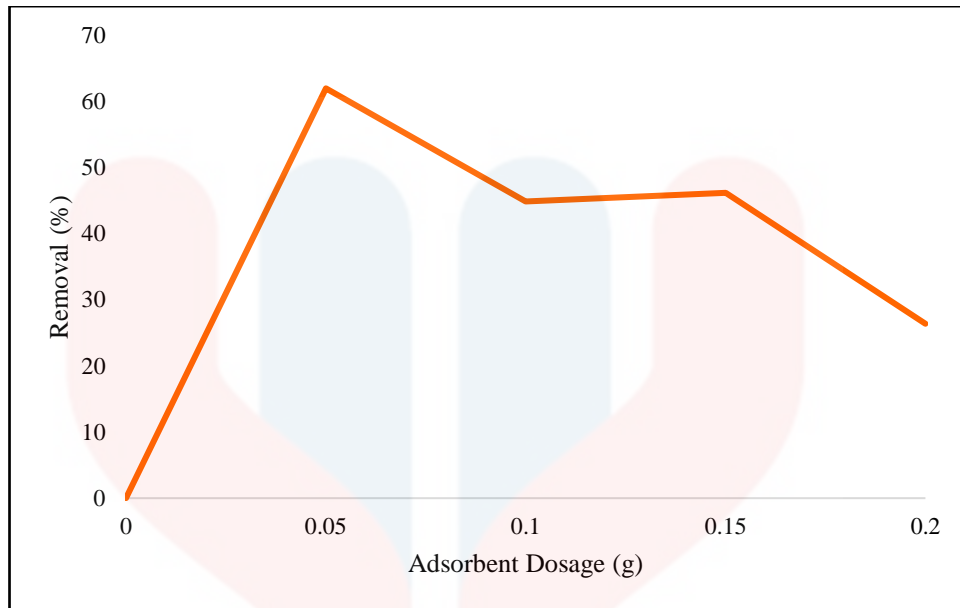
### 4.2.3 Effect of Adsorbent Dosage

The effect of CC dosage on the adsorption of methyl red was studied with methyl red concentration (20 mg/L) at different adsorbent dosage (0.05 – 0.2) g, at room temperature for 40 minutes at fixed stirring speed (200 rpm). The results obtained from this study are presented in Figure 4.6. The percentage removal of methyl red by CC decrease as the dosage of the adsorbent increase (62%, 44.89%, 46.19% and 26.41%). As the graph shown, the percentage removal was inversely proportional to the adsorbent dosage. Therefore, the adsorption of methyl red by coconut coir decreases as the adsorbent dosage increases.

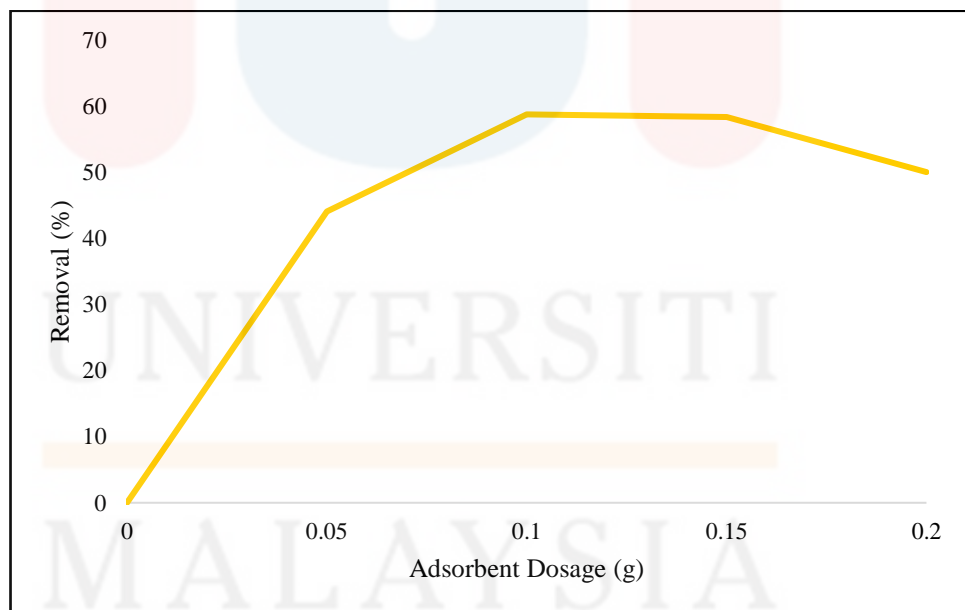
The percentage removal were plotted in Figure 4.7 as to show the dependency of adsorption methyl red by CCAC dosage in the range from 0.05 g to 0.2 g at room temperature (27°C) with 20 mg/L concentration for 20 minutes. Based on the graph shown, the highest adsorption of methyl red by CCAC was at 0.1 g adsorbent dosage with 58.76% (14.170 mg/g of adsorption capacity) of methyl red was removed. This result was similar with coconut coir dust as a low cost adsorbent for the removal of cationic dye from aqueous solution (Etim *et al.*, 2012) where the percentage removal was increase as the adsorbent dosage was increased.

Theoretically, the availability of active sites and adsorption surface was increased with the increase of the adsorbent dosage (Etim *et al.* 2012), but amount of methyl red being removed in this study did not increase along with the increase of adsorbent dosage for CC. While CCAC shows the increasing removal percentage when the adsorbent dosage also increased which is due to the increase in binding site in the adsorbent.





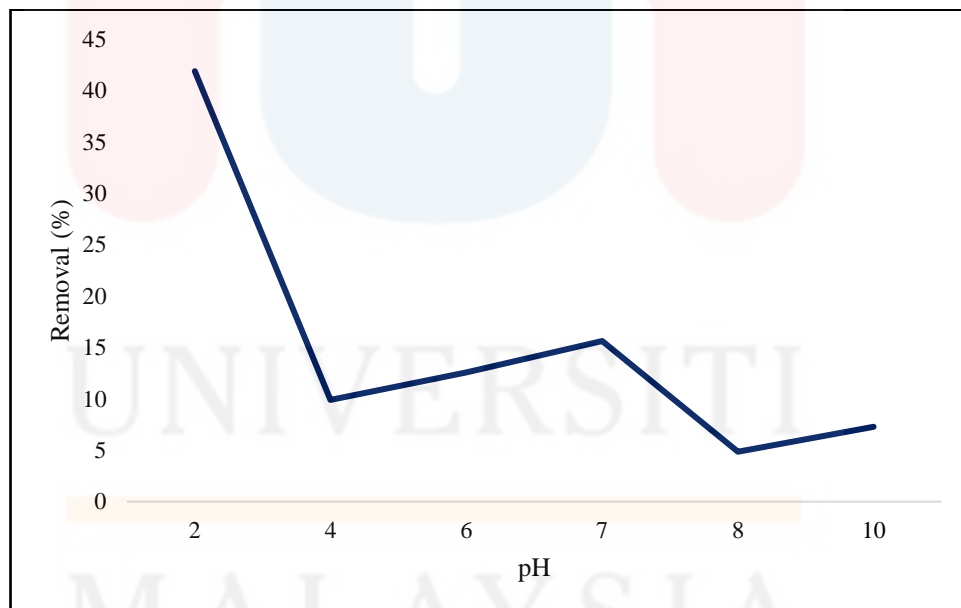
**Figure 4.6:** Effect of adsorbent dosage on the adsorption of Methyl Red onto CC at room temperature; time = 40 minutes; concentration = 20 mg/L; and stirring speed = 200 rpm.



**Figure 4.7:** Effect of adsorbent dosage on the adsorption of Methyl Red onto CCAC at room temperature; time = 20 minutes; concentration = 20 mg/L; and stirring speed = 200 rpm.

#### 4.2.4 Effect of pH

To study the effect of pH on the adsorption of methyl red dye, a solution of 20 mg/L concentration at different pH (2-10) was prepared and shaken for 40 minutes with 0.1 gram of CC with 0.4 mm of particle size. Figure 4.7 shows the effect of pH on the adsorption of methyl red dye onto CC. The result indicates that the percentage adsorption is maximum at acidic condition which is at pH 2 with 41.92% removal. The lowest percentage adsorption is at pH 8 with 4.86% removal. Based on the graph shown, from pH 2 until 4, as the pH increase, the percentage is decrease and increase at pH 7 but decrease again to the lowest percentage at pH 8 and increase again at pH 10.

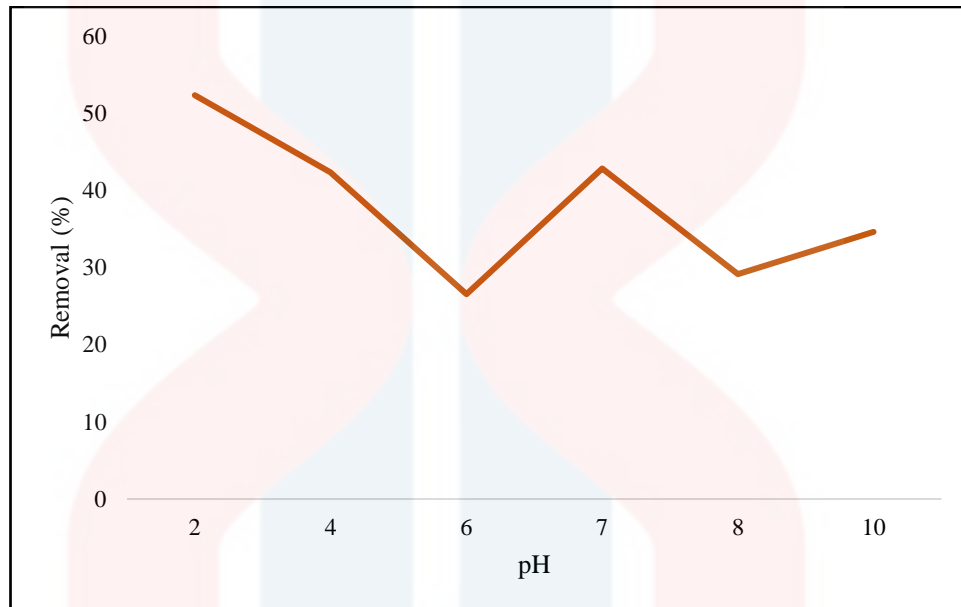


**Figure 4.8:** Effect of pH on the adsorption of Methyl Red onto Coconut Coir at room temperature; time = 40 minutes; concentration = 20 mg/L; dosage = 0.1g; and stirring speed = 200 rpm.

The effect of pH on the adsorption of methyl red dye by CCAC was performed at room temperature, with solution at 20 mg/L concentration for 20 minutes with 0.1 g adsorbent dosage at 200 rpm of stirring speed is illustrated in Figure 4.8. The result indicated that the maximum percentage adsorption on removal methyl red dye also occurred in acidic condition with 52.40% removal at pH 2. At pH 6 with 26.55% removal is the lowest percentage adsorption. Based on the graph shown, from the pH 2 until 6, as the pH increases, the percentage adsorption decrease to the lowest percentage. From pH 6 until 10, the percentage is increase at pH7 and decrease at pH 8 and slightly increase at pH 10.

The pH of a solution controls the magnitude of electrostatic charges which are imparted both by the ionized dye molecules and the charges on the surface of the adsorbent (Etim *et al.*, 2012). The increasing in the adsorption of the dye with decreasing of pH values is due to the attraction between anionic dye and excess  $H^+$  ions in the solution (Hassan & Abdulhusein, 2015). Low pH value (1.0 to 3.0) leads to an increase in  $H^+$  ion concentration in the system and the surface of the activated carbon acquires positive charge by absorbing  $H^+$  ions. Maximum in adsorption was led by positive ions ( $H^+$ ) that provides electrostatic attraction between dye molecules and the surface of adsorbent (Haris & Sathasivam, 2009). Increasing in pH value led to increase of the number of negatively charged sites (Santhi *et al.*, 2010). This shows that both of CC and CCAC obtained the maximum adsorption in acidic condition which is at pH 2. Similar trend of pH effect was observed from removal of methyl red from aqueous solution by activated carbon prepared from the *Annona squamosa* seed by adsorption (Santhi *et al.*, 2010), which it obtained the maximum adsorption in acidic condition.

Based on the results that obtained in this study, both CC and CCAC obtained their maximum percentage removal at pH 2 but CCAC has removed methyl red dye more than CC and shown that CCAC is more efficient than CC in removing methyl red dye.



**Figure 4.9:** Effect of pH on the adsorption of Methyl Red onto Coconut Coir Activated Carbon at room temperature; time = 20 minutes; concentration = 20 mg/L; dosage = 0.1g; and stirring speed = 200 rpm.

## CHAPTER 5

### CONCLUSION AND RECOMMENDATION

#### 5.1 Conclusion

The efficiency of raw material and activated carbon of coconut coir in removing methyl red dye was investigated with optimizing the effect of contact time, initial concentration, adsorbent dosage and pH at room temperature.

The result obtained showed that the adsorption capacity for both adsorbent reached its maximum in acidic condition which at pH 2. In investigating the effect of dosage, the adsorption capacity of coconut coir were decreased as increasing in the amount of adsorbent dosage. Increasing in adsorbent dosage of coconut coir activated has shown that it reached the maximum capacity with 0.1 g of dosage. The maximum capacity of adsorption methyl red onto coconut coir is within 40 minutes. Meanwhile for the coconut coir activated carbon is occurred within 20 minutes. The effect of initial concentration showed a decrease in adsorption capacity as the initial concentration increase after it reached the maximum capacity on 20 mg/L of concentration. The efficiency of coconut coir in removing methyl red dye can be observed from the range of percentage removal which is raw coconut coir remove methyl red about 40% until 60% while, coconut coir activated carbon remove methyl red was about 50% until 80%.

In conclusion, based on the study that was performed coconut coir activated carbon is more efficient than raw coconut coir as the adsorption capacity is higher when removing the methyl red dye.

## 5.2 Recommendation for Future Study

This research was able to identify the efficiency of raw coconut coir and coconut coir activated carbon in removing methyl red dye. Besides that, through this research, it can be concluded that coconut coir can be used and suitable in removing dye especially Methyl Red dye.

There are few recommendation that can be done in further research. The researcher can carry out the effect of particle size of the coconut coir because the lower particle size present a larger surface for adsorption, which tends to increase the adsorption of dye. Moreover, smaller particle size of adsorbent has greater accessibility to pores and to the greater surface area for adsorption. Besides that, the researchers can do chemical activation for this adsorbent because the corrosion of acid can increase the surface area of activated carbon produced. Hence, it can improve the adsorption. As in for better performance, the researchers can further investigate the adsorption isotherm of coconut coir where it provides important models such as Langmuir, Freundlich and Temkin isotherms in the description of adsorption behaviour. Besides that, it describes how the adsorbate interacts with the adsorbent and give explanation for the nature and mechanism of the adsorption process.

## REFERENCES

- Acharya, J., Sahu, J. N., Sahoo, B. K., Mohanty, C. R., & Meikap, B. C. (2009). Removal of chromium(VI) from wastewater by activated carbon developed from Tamarind wood activated carbon with zinc chloride. *Chemical Engineering Journal*, 150, 25-39.
- Adegoke, K. A., & Bello, O. S. (2015). Dye sequestration using agricultural wastes as adsorbents. *Water Resources and Industry*, 12, 8-24.
- Al-Momani, F., Touraud, E., Degorce-Dumas, J. R., Roussy, J., & Thomas, O. (2002). Biodegradability enhancement of textile dyes and textile wastewater by VUV photolysis. *Journal of Photochemistry and Photobiology A: Chemistry*, 153, 191-197.
- Anirudhan, T. S., & Sreekumari, S. S. (2011). Adsorptive removal of heavy metal ions from industrial effluents using activated carbon derived from waste coconut buttonns. *Journal of Environmental Science*, 23(12), 1989-1998.
- Arora, S. (2014). Textile Dyes: It's Impact on Environment and its Treatment. *J Bioremed Biodeg*, 5(3), 6199.
- Bachrun, S., Noni, A. R., Annisa, S. H., & Arif, H. (2016). Preparation and Characterization of Activated Carbon from Sugarcane Bagasse by Physical Activation with Carbon Dioxide Gas. *IOP Conf. Series: Materials Science and Engineering*, 105, 1-8.
- Billy, T. G., Puziah, A. L., & Taufiq, Y. Y. (2013). Physical Preparation of Activated Carbon from Sugarcane Bagasse and Corn Husk and Its Physical and Chemical Characteristics. *International Journal of Engineering Research and Science & Technology*, 2(3), 1-14.
- Carmen, Z., & Daniela, S. (2012). Textile organic dyes—characteristics, polluting effects and separation/elimination procedures from industrial effluents—a critical overview. *Organic Pollutants Ten Years After the Stockholm Convention-Environmental and Analytical Update* (pp. 55-81). InTech: Croatia. Retrieved from <http://www.intechopen.com/books/organic-pollutants-ten-years-after-the-stockholm-convention-environmental-and-analytical-update/textile-organic-dyes-characteristics-polluting-effects-and-separation-elimination-procedures-from-in>
- Chaudhuri, M., Elmolla, E. S., & Rashidah, O. (2009). Removal of reactive dyes from aqueous solution by adsorption on coconut coir activated carbon., (pp. 1-4). Kuala Lumpur. Retrieved 8-10 December, 2009, from [https://www.academia.edu/1458883/Removal\\_of\\_Reactive\\_Dyes\\_from\\_Aqueous\\_Solution\\_by\\_Adsorption\\_on\\_Coconut\\_Coir\\_Activated\\_Carbon](https://www.academia.edu/1458883/Removal_of_Reactive_Dyes_from_Aqueous_Solution_by_Adsorption_on_Coconut_Coir_Activated_Carbon)
- Chaudhuri, M., Nurul, A. M., & Elmolla, E. S. (2012). Coconut coir activated carbon: an adsorbent for removal of textile acid azo dye from aqueous solution. *IEEE Colloquium on Humanities, Science and Engineering (CHUSER)*, (pp. 58-62). Kota Kinabalu.
- Cobb, A., Warms, M., Maurer, E. P., & Chiesa, S. (2012). Low-Tech Coconut Shell Activated Charcoal Production. *International Journal for Service Learning in Engineering*, 7(1), 93-104.

- Etim, U. J., Inam, E., Umoren, S. A., & Eduok, U. M. (2013). Dye Removal from Aqueous Solution Using Coconut Coir Dust Extract-modified Polyvinyl alcohol: A Novel Adsorbent. *International Journal of Environment and Bioenergy*, 5(2), 62-79.
- Etim, U. J., Umoren, S. A., & Eduok, U. M. (2012). Coconut coir dust as a low cost adsorbent for the removal of cationic dye from aqueous solution. *Journal of Saudi Chemical Society*, 1-10.
- Faradilla, L. (2006). *Dye Removal from Simulated Wastewater by using Empty Fruit Bunch as an Adsorption Agent*. College University of Engineering and Technology Malaysia, Faculty of Engineering and Natural Resource.
- Gupta, A., Yadav, R., & Devi, P. (2011). Removal of Hexavalent Chromium using Activated Coconut Shell and Activated Coconut Coir as Low Cost Adsorbent. *The IIOAB Journal*, 2(3), 8-12.
- Haris, M. R. H. M., & Sathasivam, K. (2009). The Removal of Methyl Red from Aqueous Solutions Using Banana Pseudostem Fibers. *American Journal of Applied Sciences*, 6(9), 1690-1700.
- Hassan, A. A., & Abdulhussein, H. A. (2015). Methyl Red Dye Removal From Aqueous Solution by Adsorption on Rice Hulls. *Journal of Babylon University, Engineering Sciences*, 23(3), 627-637.
- Hui, T. S., & Muhammad Abbas, A. Z. (2015). Potassium hydroxide activation of activated carbon: a commentary. *Carbon Letters*, 16(4), 275-280.
- Kharat, D. S. (2015). Preparing Agricultural Residue Based Adsorbents for Removal of Dyes from Effluents - A Review. *Brazilian Journal of Chemical Engineering*, 32(01), 1-12.
- Khedari, J., Charoenvai, S., & Hirunlabh, J. (2003). New insulating particleboards from durian peel and coconut coir. *Building and Environment*, 38, 435-441.
- Kyzas, G. Z., & Kostoglou, M. (2014). Green Adsorbent for Wastewater: A Critical Review. *Materials*, 7, 333-364.
- Mahmoud, M. A., Poncheri, A., Badr, Y., & Abd El Wahed, M. G. (2009). Photocatalytic degradation of methyl red dye. *South African Journal of Science*, 105, 299-303.
- Mohammed, J., Noraini, J., Lai, S. P., & Abdullahi, M. E. (2013). Removal of Colour from Waste Water Using Coconut Shell Activated Carbon (CSAC) and Commercial Activated Carbon (CAC). *Jurnal Teknologi (Sciences & Engineering)*, 60, 15-19.
- Mohammed, M. A., Shitu, A., & Ibrahim, A. (2014). Removal of Methylene Blue Using Low Cost Adsorbent: A Review. *Research Journal of Chemical Sciences*, 4(1), 91-102.
- Mohd, A. A., Norhidayah, A., & Bello, O. S. (2015). Modified durian seed as adsorbent for the removal of methyl red dye from aqueous solutions. *Appl Water Sci*, 5, 407-423.



- Muthuraman, G., & Teng, T. T. (2009). Extraction of methyl red from industrial wastewater using xylene as an extractant. *Progress in Natural Science*, 19(10), 1215-1220.
- Noridah, A. (2009). *Removal Methyl Red from Aqueous Solution Using Dried Water Hyacinth (Fichhornia Crassipes)*. Universiti Malaysia Pahang, Faculty of Chemical & Natural Resources Engineering, Malaysia.
- Phatai, P., Klinkaewnarong, J., & Yaiyen, S. (2014). Adsorption of Methyl Violet Dye from Aqueous Solutions by Activated Carbon Produced from Tamarind Seed. *Advanced Materials Research*, 911, 326-330.
- Pirbazari, A. E., Saberikhah, E., Badrouh, M., & Emami, M. S. (2014). Alkali treated Fourmanat tea waste as efficient adsorbent for methylene blue adsorption from aqueous solution. *Water Resources and Industry*, 6, 64-80.
- Pirkarami, A., & Olya, M. E. (2014). Removal of dye from industrial wastewater with an emphasis on improving economic efficiency and degradation mechanism. *Journal of Saudi Chemical Society*, 1-8.
- Rita, K. (2012). Textile dyeing industry an environmental hazard. *Natural Science*, 4(1), 22-26.
- Salleh, M. M., Mahmoud, D. K., Karim, W. A., & Idris, A. (2011). Cationic anionic dye adsorption by agricultural solid waste: a comprehensive review. *Desalination*, 280, 1-13.
- Santhi, T., Manonmani, S., & Smitha, T. (2010). Removal of Methyl Red from Aqueous Solution by Activated Carbon Prepared From the Annona Squamosa Seed by Adsorption. *Chemical Engineering Research Bulletin*, 14, 11-18.
- Sharma, Y. C., Uma, & Upadhyay, S. N. (2009). Removal of a Cationic Dye from Wastewaters by Adsorption on Activated Carbon Developed from Coconut Coir. *Energy & Fuels*, 23, 2983-2988.
- Shen, Y., Wang, S., Tzuo, Y., Yan, Y., & Kuan, W. (2012). Removal of hexavalent Cr by coconut coir and derived chars - The effect of surface functionality. *Bioresource Technology*, 104, 165-172.
- Sivakumar, B., Kannan, C., & Karthikeyan, S. (2012). Preparation and Characterization of Activated Carbon prepared from Balsamodendron Caudatum Wood Waste through Various Activation Process. *RASAYAN J. Chem*, 5(3), 321-327.
- Subhrajyoti, D. (2010). *Removal of Congo Red Dye onto Coconut (Cocos nucifera) Shell AND Bael (Aegle marmelos) Extracts Using Taguchi Approach*. National Institute of Technology Rourkela Orissa, Department of Chemical Engineering, India.
- Tahir, H., Sultan, M., & Jahanzeb, Q. (2008). Removal of basic dye methylene blue by using bioabsorbents Ulva lautuca and Sargassum. *African Journal of Biotechnology*, 17(15), 2649-2655.
- Taimur, K., Mohamed Kutty, S. R., & Chaudhuri, M. (2010). Adsorptive Removal of Reactive Yellow 15 from Aqueous Solution by Coconut Coir Activated Carbon. *Adsorption Science & Technology*, 28(7), 657-667.

- Virginia, H. M., Josafat, G. S., & Jose Ivan, B. L. (2012). Thermal Treatments and Activation Procedures Used in the Preparation of Activated Carbons. In H. M. Dr. Virginia, *Lignocellulosic Precursors Used in the Synthesis of Activated Carbon - Characterization Techniques and Application in the Wastewater Treatment* (pp. 19-36). InTech.
- Viswanathan, B., Indra Neel, P., & Varadarajan, T. K. (2009). *Methods of Activation and Specific Application of Carbon Materials*. Indian Institute of Technology MADRAS, Department of Chemistry. India: National Centre for Catalysis Research.
- Yamin, Y., Mohd Zobir, H., & Faujan, A. (2007). Adsorption of Methylene Blue onto Treated Activated Carbon. *The Malaysian Journal of Analytical Sciences*, 11(11), 400-406.

## APPENDICES A

### THE PREPARATION OF CALIBRATION STANDARD

Standard solution concentration (mg/L)	2	4	6	8	10
Volume of standard solution added (mL)	1ml	2ml	3ml	4ml	5ml
Absorbance Value	0.11	0.21	0.31	0.38	0.48
Equation	$y = 0.0047x + 0.0012$				



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## APPENDICES B

### THE ADSORPTION CAPACITY AND THE PERCENTAGE ADSORPTION OF COCONUT COIR AND COCONUT COIR ACTIVATED CARBON

#### APPENDIX B.1: Effect of contact time

##### Coconut coir

Contact Time (min)	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
0	0	0	0	0
10	0.102	0.068	3.255	33.73
20	0.102	0.071	2.968	30.75
30	0.102	0.051	4.883	50.59
40	0.102	0.047	5.266	54.56
50	0.102	0.055	4.490	46.63
60	0.102	0.054	4.596	47.62

##### Coconut Coir Activated Carbon

Contact Time (min)	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
0	0	0	0	0
10	0.077	0.024	5.075	69.92
20	0.077	0.018	5.649	77.84
30	0.077	0.026	4.883	67.28
40	0.077	0.031	4.405	60.69
50	0.077	0.023	5.171	71.24
60	0.077	0.025	4.979	68.60

## APPENDIX B.2: Effect of initial concentration

### Coconut coir

Concentration (mg/L)	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
0	0	0	0	0
10	0.07	0.058	1.149	17.44
20	0.102	0.047	5.266	54.56
30	0.111	0.093	1.724	16.39
40	0.128	0.1	2.681	22.08
50	0.124	0.118	0.575	4.89

### Coconut coir Activated Carbon

Concentration (mg/L)	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
0	0	0	0	0
10	0.045	0.024	2.011	47.95
20	0.077	0.031	4.405	60.69
30	0.092	0.051	3.925	45.15
40	0.1	0.063	3.542	37.45
50	0.118	0.08	3.638	32.53

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### APPENDIX B.3: Effect of adsorbent dosage

#### Coconut coir

Adsorbent Dosage (g)	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
0	0	0	0	0
0.05	0.077	0.03	4.5	62
0.1	0.077	0.043	3.255	44.85
0.15	0.077	0.042	3.351	46.17
0.2	0.077	0.057	1.915	26.39

#### Coconut coir Activated Carbon

Adsorbent Dosage (g)	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
0	0	0	0	0
0.05	0.253	0.142	10.628	44.08
0.1	0.253	0.105	14.170	58.78
0.15	0.253	0.106	14.074	58.38
0.2	0.253	0.127	12.064	50.04

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#### APPENDIX B.4: Effect of pH

##### Coconut coir

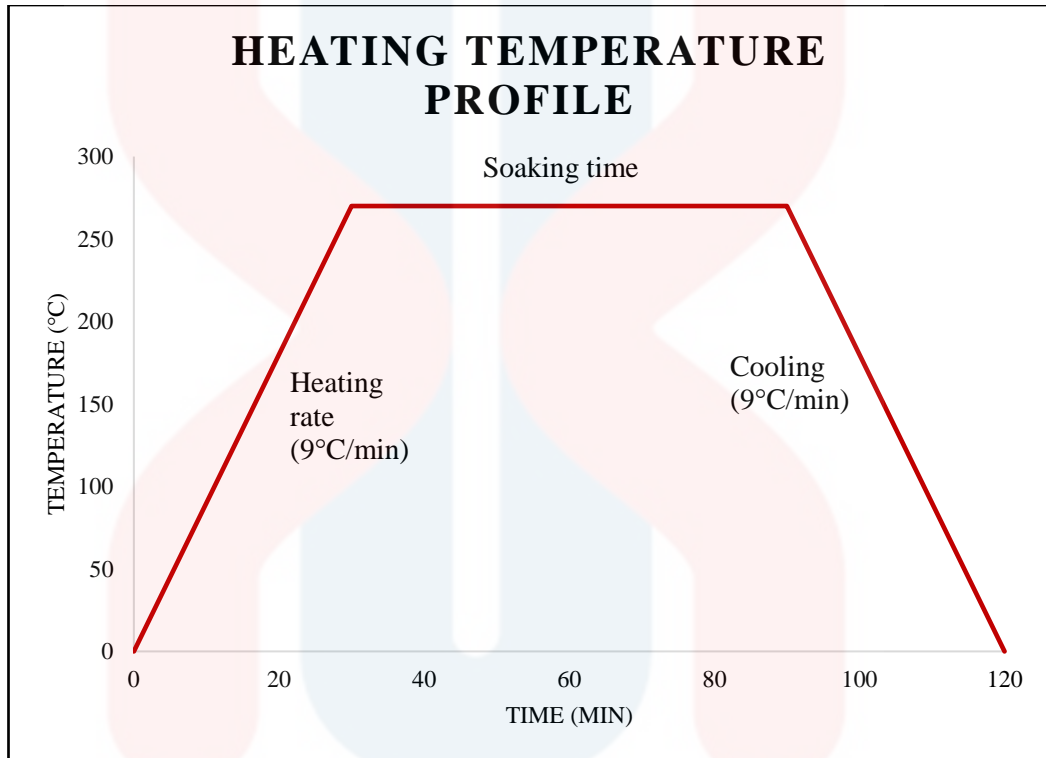
pH	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
2	0.068	0.04	2.681	41.92
4	0.183	0.165	1.724	9.9
6	0.295	0.258	3.543	12.59
7	0.475	0.401	7.085	15.62
8	0.392	0.373	1.819	4.86
10	0.688	0.638	4.788	7.28

##### Coconut coir Activated Carbon

pH	Initial Absorbance	Final Absorbance	Adsorption capacity, $q_e$ (mg/g)	Removal (%)
2	0.068	0.033	3.351	52.40
4	0.183	0.106	7.372	42.35
6	0.295	0.217	7.468	26.55
7	0.475	0.272	19.436	42.85
8	0.392	0.278	10.915	29.17
10	0.688	0.45	22.788	34.65

## APPENDICES C

### HEATING TEMPERATURE PROFILE



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## APPENDICES D

### APPENDIX D.1: Coconut Coir Raw Material



### APPENDIX D.2: Coconut Coir after sieve to size 0.4mm



### APPENDIX D.3: Muffle Furnace



**APPENDIX D.4: Coconut Coir Activated Carbon**



**APPENDIX D.5: Orbital Shaker**



**APPENDIX D.6: pH meter**



**APPENDIX D.7: UV-Vis Spectrophotometer**



**APPENDIX D.8: Oven (105 °C)**



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