Absorbent from \textit{Cucurbita Pepo.L} seed for Cu(II) removal

P M L Muhamad Faizal\textsuperscript{1*}, F Mohd Azrizal\textsuperscript{1}, M Jurainah\textsuperscript{1}, M N Nur Hazwani\textsuperscript{2}, N K Mohamad Nasran\textsuperscript{3}

\textsuperscript{1,2} Faculty Faculty of Civil Engineering Universiti Teknologi MARA, Cawangan Pulau Pinang, Malaysia.
\textsuperscript{3} School of Chemical Engineering Universiti Sains Malaysia, Malaysia.
\textsuperscript{4} Department of Electrical Engineering Politeknik Seberang Perai, Malaysia.

*faizal.pakir@uitm.edu.my

**Abstract.** Copper Cu (II) is one of the toxic contaminants of heavy metal in wastewater. The performance of activated carbon (AC) produced from \textit{Cucurbita Pepo.L} seed as an adsorbent for the removal Cu is presented in this paper. The preparation of CPSAC uses 2-step physical activation assisted by microwave and CO\textsubscript{2}. The effect of contact time and initial concentration were examined. The batch study was conducted, and the data shows that the absorption was plotted better by using Langmuir isotherm.

1. Introduction

Several industries such as paint pigments, glass production, mining operation, metal plating, and battery manufacturing process produced wastewater that contains contaminants of heavy metal \cite{1}. In Malaysia, heavy metals present in industrial effluent is one of the major concerns, especially it is discharged directly into the nearby drainage and stream without treatment. Copper, zinc, gold, mercury, chromium, nickel, iron etc. are the example, heavy metal in the water bodies \cite{2}. Several methods have been used to treat wastewater has heavy metals contaminant. Adsorption has been used as a method for removal of the heavy metal contaminant from wastewater treatment. AC from agriculture waste has benefited to society, economically and environmentally. \textit{Cucurbita Pepo.L} seed waste frequently contributes to an increase in waste. These wastes have identified in several places such as premise and household. In this study, has identified the \textit{Cucurbita Pepo.L} seed are generated at the food court from Kristal Penang is substantially produced. The seeds are disposed of and become waste. Thus, AC can change that agriculture waste by-product into a valuable product.

2. Material and Methods

2.1 Activated Carbon Preparation

\textit{Cucurbita Pepo.L} seed was obtained from Kristal Food Court, Universiti Teknologi MARA Cawangan Pulau Pinang, Malaysia. The shell was separated. The sample was washed and dried at 105\degree C for 24 hours to remove the moisture content. Then, the sample was crushed to the desired mesh and sieved to the size of 2-3.75mm. The production of AC was divided into two phases. The first phases are the production of char by using a tube furnace, and the second phase covered the
activating process of char by using the microwave. The carbonization process is carried out by loading the dried and sieved based on measured of Cucurbita Pepo.L seed in a tube furnace. The heating temperature was continued until the temperature achieves until 500°C. After the temperature was achieved, the muffle furnace was waiting until 30 minutes to cool down the temperature. Activation the char in the microwave is controlled the response includes activation power, activation time and carbon dioxide flow. Physical activation method using CO₂ was used to activate the char. The power, radiation time and CO₂ flow used to produce Cucurbita Pepo.L seed activated carbon (CPSAC) was 264 Watt, 4 minutes and 100 cm³, respectively.

2.2 Effect of Contact Time
The effect of contact time on the adsorption of Cu (II) from synthetic wastewater is analyzed. 100 ml of synthetic wastewater sample is prepared and poured into each conical flask containing the adsorbent with concentration, 2 mg/L with shaking speed at 200 rpm. The effect of contact time was determined, which is the contact time used in the experiment was 20 min, 40 min, 60 min, 80 min, and 100 min and 120 minutes. The adsorbent dosage of AC was 0.2 g each concentration. After shaking, each of the samples was filtrated using filter paper, and the final concentration was analyzed.

2.3 Effect of concentration
The effects of the concentration of copper and contact time were conducted to achieve optimum performance. 100 ml conical flask of synthetic wastewater with different concentration (1, 2, 3, 4 and 5 mg/L) were prepared and added with 0.2 g of CPSAC. This solution was shaken for 2 hours using orbital shaker at 200 rpm. The CPSAC in the solution was filtered by using filter paper. The concentration of Cu (II) after filtration is the final heavy metal concentration in synthetic wastewater. The effect of concentration of Cu (II) solution on adsorption study was investigated.

2.4 Adsorption Isotherm Models
Most commonly adsorption isotherm used are Langmuir Isotherms and Freundlich Isotherms. In this study, Freundlich Isotherm and Langmuir Isotherm were used to analyze and described the equilibrium isotherms wherein Freundlich Isotherms to determine the isotherm parameter which are Kf and n, the graph of log qe versus log Ce was plotted. While in Langmuir Isotherm, in order to determine the isotherm parameters which are qm and K, a graph of Ce/qe versus Ce was plotted.

2.5 Kinetic Studies
For kinetic study, the concentration aqueous solutions have been obtained at a preset time intervals. The adsorption’s quantity at time t, qₜ (Cu (II)/g), was evaluated where Cₒ and Cₜ (Cu (II)/L) are the liquid-phase concentrations of adsorbate at initial and any time t, respectively. V is the volume of the solution (L) and W is the mass of adsorbent used (g).

3. Results and Discussion

3.1 Effect of contact time
Effect of contact time for the percentage removal of Copper, Cu (II) and concentration shown in Figure 1, which is using 1 mg/L to 5 mg/L Copper concentration. The adsorbent dosage of 0.2 g is used to determine the equilibrium time for the optimum adsorption capacity. The concentration against contact time was plotted represent that the efficiency of reduced concentration of Cu (II) in the 120 minutes of contact time is most efficient which is changes from 2 mg/L to 0.58 mg/L with the highest percentages removal of Cu (II) is 70.83%. Trough out the rest of contact time of the experiment, the rate of efficiency of the Cu (II) concentration also decrease which is changes from 2 mg/L into 1.06 mg/L at 20 minutes of contact time with 47.17% of percentage removal of heavy
metal from synthetic wastewater as shown in the Figure 1. It can be representing that the removal of concentration higher when the contact time increase.

![Figure 1](image1.png)

**Figure 1** Contact Time versus Concentration and Percentage Removal.

### 3.2 Effect of concentration

The dosage of AC used is 0.2g, which then added into each of the conical flasks. The amount of synthetic wastewater used is 100 mL solution with different initial concentration, which varies from 1 mg/L to 5 mg/L but constant contact time, which is 120 minutes. Figure 2 shows the effect of different initial concentration on the adsorption capacity of Cu (II) in the synthetic wastewater. The removal of Cu (II) in the synthetic wastewater is linearly decreasing when the value of initial concentration is increasing. This shows that the removal of Cu (II) in the synthetic wastewater depends on the value of initial concentrations.

![Figure 2](image2.png)

**Figure 2** Percentage Removals versus Initial Concentration.
3.3 Adsorption Isotherm Models

Equilibrium isotherms in this study were analyzed using Langmuir and Freundlich isotherm for describing Copper, Cu (II) adsorption by CPSAC. As shown in Figure 3, the values of the Freundlich constants and correlation coefficient are 0.87. The values on n are more than 1, and it indicates the strongly favour the nature of adsorbent. The correlation coefficient, which ranges from 0.86 to 0.97, shows that the data fit well with the Freundlich equation [3].

From Figure 4, the plot Ce/qe versus Ce represent Langmuir isotherm constant, which is qm and K1 were calculated from the slope and intercept. The constant will represent the maximum adsorption capacity. The correlation coefficient of 0.83 indicates that study fitted well with the model.

Table 1 shows the Langmuir isotherm model gave slightly closer fitting than the Freundlich isotherm model. The $R^2$ value for Langmuir is higher than the $R^2$ of the Freundlich isotherm model. This indicated the homogenous nature of Cu (II) onto binding sites of CPSAC that are identical equivalent. Adsorption intensities were derived from Freundlich coefficient, where $1/n$ values of Cu (II) were less than one, which indicates a normal Freundlich[4].
3.4 Kinetic Studies

The kinetics of adsorption describes the rate of adsorbate uptake on activated carbon and it controls the equilibrium time [5]. Kinetic studies were analyzed by using Pseudo-First-order model and Pseudo-Second-order. Adsorption kinetic model was plotted for Cu (II) on CPSAC. Figure 5 shows the linearity of Log (qe-qt) against time at 0.2 gram of adsorbent, while Figure 6 shows plotted t/qt directly proportional with time and gives a straight line relationship. Based on the findings show that adsorption of Cu (II) on adsorbent fits the Pseudo-Second-Order kinetic model. The $R^2$ was obtained 0.82 and 0.99 for Pseudo-First-Order and Pseudo-Second-Order kinetic respectively.

| Isotherm Constant for The Adsorption of Cu (II). |
|-----------------------------------------------|
| Langmuir Constant | Freundlich Constant |
| $K_L$ | $R^2$ | $K_F$ | $1/n$ | $R^2$ |
| 0.69 | 0.87 | 0.15 | 0.87 | 0.83 |

![Figure 5 Pseudo-First-Order Model Kinetic.](image1)

![Figure 6 Pseudo-Second-Order Model Kinetic.](image2)
4. Conclusions
This paper has investigated the optimum preparation of CPSAC by physical activation assisted by microwave for the removal of Cu (II) in the synthetic wastewater. The results revealed that CPSAC as a good precursor to produce an efficient AC with great performance in removing the Cu (II) in the synthetic wastewater.

Acknowledgement
The authors are grateful for the support and all the equipment provided by Universiti Teknologi MARA Cawangan Pulau Pinang.

References
[1] E Bernard A Jimoh J O R 2013 *J. of Chemical and undefined* Heavy metals removal from industrial wastewater by activated carbon prepared from coconut shell researchgate.net.
[2] S K Gunatilake 2015 Methods of Removing Heavy Metals from Industrial Wastewater Multidiscip. Eng. Science Stud. 1, 1 p. 12–18.
[3] T O Chime C C Onyema and F C Uzoh 2016 Kinetics and Thermodynamic Studies of Adsorption of Lead From Paint Effluent Using Locally Activated Carbon vol. 4, 11, p. 32–49.
[4] D E Egirani A R Baker and J. E. Andrews 2005 Copper and zinc removal from aqueous solution by mixed mineral systems I. Reactivity and removal kinetics *J. Colloid Interface Sci.* vol. 291, 2, p. 319–25.
[5] Yu Bian Zhaoyong Bian Junxiao Zhang Aizhong Ding Shaolei Liu Lei Zheng Hui Wang 2015 Adsorption of cadmium ions from aqueous solutions by activated carbon with oxygen-containing functional groups *Chinese J. Chem. Eng.* 23, 10, p. 1705–1711.