University of Thi-Qar Journal of Science (UTsci)
The 4th Scientific Conference of Science College/ University of Thi_Qar
Volume (7), No.2

Use Activated Carbon Prepared from Some Palm Waste to Remove Co(II) and Cu(II) from Sewage Water

Firas Ali Hussein Alhameedawi
Department of Chemistry
Collage of Science/ University of Al Zaghazagh, Egypt.

Mohammed Khlaif Challab*
Department of Chemistry
Collage of Science/ University of Al Zaghazagh, Egypt.
email: mohammadchellab@gmail.com

Mohammed Turki Khathi
Department of Chemistry
Collage of Science / University of Thi-Qar, Iraq.

***Abstract*— This study included the use of palm waste such as fiber and tree leaves palm, as low cost adsorbents for removal of Cu(II) and Co(II) from sewage water via preparation of activated carbon. The results are showed that the adsorption equilibrium time was 35 and 45 min for both metals by tree leaves and fiber respectively. The obtained results indicated that over pH (6.5) there is an increased optimum of adsorption for both metal ions. The study showed that (0.4 g) of adsorbent is very ideal to obtain the best adsorption for both studied ions. The capacity of the adsorbents Co(II) to adsorb high than Cu(II).

***Keywords*— Activated carbon, Palm waste, Removal of Co(II) and Cu(II), Sewage water.**

IV. INTRODUCTION

The water pollution is the most important because of its relationship with living organisms . Water is an essential liquid for life. The importance of water to humans comes directly after oxygen. Humans need a few liters of water a day. Water must be pure in certain limits and if the water is contaminated, humans are exposed to many diseases such as cholera and others (Abaychi and Douabul, 2008). However, after the industrial revolution, a new classification of water contaminants, conventional, non-conventional and toxic pollutants, has been developed because of the entry of water into a base material in the industry. The establishment of industries close to water sources and their discharge to or near the waterways contribute to an effective role in polluting the water with chemical contamination. These pollutants are heavy metals such as lead, chromium, nickel, copper and cadmium where they are toxic, if they increase their concentration, some of them toxic in concentrations a few (Martinez, 2009).

Therefore it became necessary to get rid of the heavy metals because of the environmental problems of humans, so it was one of the priorities of scientific research for researchers and have used many different methods over the past years, including physical and chemical methods that use environmentally friendly materials are always preferred, including the use of agricultural waste to remove these pollutants. The method of adsorption is considered the best in the process of removing heavy metals (Tan et al., 2008). In this study was used of palm waste such as fiber and tree leaves palm as low cost adsorbents for removal of Cu(II) and Pb(II). A number of researchers have addressed this study.

Giraldo and Moreno (2008) suggested preparing an active carbon from cane sugar bagasse African palm pit and sawdust activated by HNO3 . for adsorption of Pb(II) in aqueous solutions. Mohamad et al., (2009) studied the removal of Cu (II) ions from aqueous solutions by soda lignin as an absorbent using a batch adsorption system in this experiment. Ahmed, (2010) studied use wastes of the Iraqi date palm tree was to removal of heavy metal such as (Cu (II), Cd (II) and Zn (II)) from Industrial wastewater using batch adsorption process. Aljendeel (2011) studied the removal of heavy metals by reverse osmosis (copper sulfate hex hydrate (CuSO4.6H2O), nickel sulphate hex hydrate (NiSO4.6H2O) and zinc sulfate hex hydrate (ZnSO4.6H2O) from aqueous solutions. Moyo et al., (2013) suggested that activated carbon be prepared from maize tassel for the adsorption of Pb (II) ions. The product obtained was characterized and utilized for the removal of lead from aqueous solutions. Sulaymon et al., (2014) studied of the removal Pb (II) and Cr (III) by dead anaerobic biomass (DAB) in single and binary systems has been studied using fixed bed adsorber. Rezania et al., (2016) explained use water plants that are lotus, duck weed and Eichhornia crassipes were used to remove heavy metals (Mn, Cu, Cd, Pb, Zn and Fe) from contaminated water. Kumar and Jena (2017) studied the preparation of carbon activated from fox nutshell which are used for adsorption Cr (VI) by chemical activation with H3PO4 . Al-Jaberi and Mohammed, (2018) explained was to investigate the effecting of pH parameter on the feasibility of lead removal from simulated wastewater using an electrochemical system.

V. EXPERIMENTAL

A. Materials and solution

1-1 Chemical materials

High purity chemicals were used such as Co (NO3)2, CuCl2.2H2O, C2H5OH and KBr), distilled water was used in diluted solutions for washing tools and samples. Deionized water was also used to wash samples.

1-2 Standard solutions

1-2-1 Lead standard solution

An adsorbate standard solution of 100 mg.L-1of Co(II) was prepared by dissolving 0.1598 g of lead nitrate

Co(NO3)2 in 1000 mL of distilled water. This solution was served as stock solution for further uses.

1-2-2 Copper standard solution

An adsorbate standard solution of 100 mg.L-1 of Cu(II) was prepared by dissolving 0.268 g of $CuC_{l2}.2H_2O$ in 1000 mL of distilled water. The solution was served as stock solution for further applications.

VI. PROCEDURES

1- Collection of samples

a. sewage water samples collected from the water depth (45 - 50 cm) from the sewage water of the Musayyib hospital in the city of Babylon. Three samples were taken and the quarterly mean of the readings was taken, taking some field measurements of the water environment from which samples were taken,10 liter bottles of clean polyether were used to collect water samples for physical and chemical tests. The nozzles were closed tightly to prevent air entering after the collection bottles were filled with the sample water before filling and adding a few drops of chloroform as a keeper and recorded the necessary information on each vial and finish the tests wash the bottles well and dry until further samples are taken.

b. The another site was taken samples of the waste of palm (fiber and leaves palm) for the purpose of use in the study, where the two samples are taken from orchards of an area Nile in the city of Babylon.

2- The adsorbents

Two types of adsorbents were used in this work, leaves and fiber of Palm dates production, was the adsorbents of date palm tree of type (Khastawi) was obtained from Babylon city. The active groups, such as amino, carbonyl and hydroxyl, present in the adsorbent are responsible for metal ions adsorption.

3- Activation of samples

The tree palm leaves and fiber were divided into sections, dried at (80 oC) for 10 hours, left to cool at room temperature and kept in air light containers. The BET surface area of the powders were measured before and after activated to tree palm leaves and fiber charcoal powders at 750 oC, the BET surface area of tree leaves has been found to equal 260 m2.g-1 and 330 m2.g-1 for palm fiber, these values are very high comparative with other carbons which have a surface area about 10-100 m2.g-1. The adsorption capacity of carbon is strongly attributed to the chemical structure of its surface .

Table (1). The BET surface area of byproducts before and after activation

Adsorbate	BET surface area before activation $m^2.g^{-1}$	BET surface area after activation $m^2.g^{-1}$	Mesh mm
Leaves palm	0.9	260	0.5
Fiber palm	0.8	330	0.5

4- Adsorption process

The adsorption for heavy metals solutions were determined by using batch adsorption experiment (50 mL) of heavy metals solution of a known concentration ranged from (6 mg,L-1) to (24 mg.L-1) were added separately to volumetric flasks containing (0.4 g) of each adsorbents. At a certain temperature 25 oC and optimum pH, the flasks were shaken in a thermostatically controlled shaker incubator at a constant speed (10 cycler per minutes) for the required equilibrium time. The mixtures were then separated by centrifugation at (1500 rpm) for (10 minutes) and were filtered by using (No.42) what man filter paper.

The metal equilibrium concentrations were measured by using Atomic Absorption Spectrometer (AAS) and comparing the experimental data with the calibration curve. The amount of heavy metals adsorbed were calculated from the initial and final concentrations and the volume of solution according to the following equation Bansal and Goyal (2005).

$$Q_e = \frac{V(C_o - C_e)}{m}$$

Where : V = Volume of solution (L) , Co= initial concentration (mg.L-1) Ce= equilibrium concentration (mg.L-1) , m = weight of adsorbent (g) .

The amount of adsorption is expressed by (Qe) which is defined as the quantity of adsorbate in (mg) held by weight of adsorbent in (0.4 g).

5- Factors affecting adsorption of heavy metals

The main factors investigated for affecting mineral absorption were pH, temperature, adsorbent weight (fiber and leaves palm), contact time and initial concentration of heavy metals.

5-1 Effect of pH

An experiment was carried out at pH (3.5, 6.5, 7.5, 8.5 and 9.5) for heavy metal solution. The acid and alkaline pH of the solution has been modified by adding the required quantities of buffers solution.

5-2 Effect of contact time

The effect of period of contact time between the adsorbent and adsorbate on the removal of the metal ions was determined by keeping pH, temperature, weight and initial concentration constant the times were (5.0, 10, 20, 35, 45, 60, 80 and 100 min).

5 -3 Effect of adsorbent weight

The effect of different weight of adsorbents, were (0.1, 0.2, 0.4, 0.6, 0.9 and 1.3 g) for adsorbent were assessed and the percentage of adsorption for different weights was determined by keeping all other factors constant.

5-4 Effect of temperature

The adsorption of heavy metals were studied at temperatures of 25 °C, 35 °C, 50 °C and 60 °C, all other factors were kept constant.

5 -5 Effect of heavy metal initial concentration

This experiment was conducted with several metal concentrations which were (6, 12, 18 and 24 mg.L-1), with fixation of others factors.

6- Applications

Optimal conditions have been applied to remove heavy metals Co(II) and Cu(II) from sewage water using two samples of activated carbon as adsorbent material.

IV. Result and Discussion

1- Factors affecting adsorption of heavy metals

1-1 Effect of pH

The pH was tested (3.5, 6.5, 7.5, 8.5 and 9.5) for a heavy metal solution, the effect of the variation in the pH of the solution on adsorption extent of Co(II) and Cu(II) on the (fiber and leaves palm), was examined in a series of experiments at varying (pH) between 3.5 and 9.5 while keeping all the remaining influencing factors constant. These results indicated that in pH (6.5) there is an increase optimum of adsorption amounts for all element ions.

However the adsorption amounts for all element ions decrease at pH above (6.5) due to the decreases of the negative charge of the surface, or caused by contamination which attributed to extended of metals ions to precipitation in base medium solutions not precipitation may become significant mechanism in the metal removal process (McKinney and Pruden, 2012).

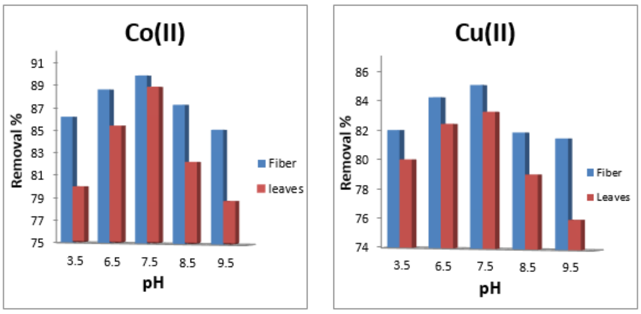


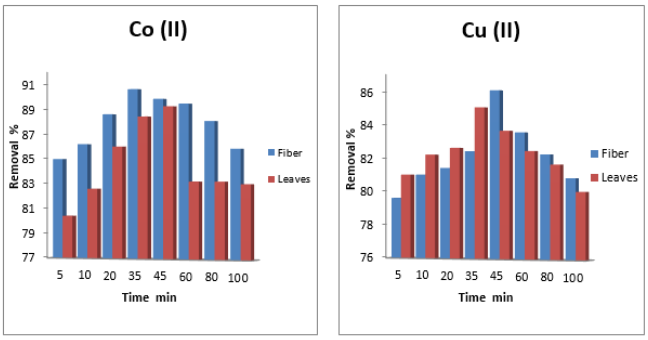
Figure (1) : Effect of pH on rate of Co(II) and Cu(II) removal for the fiber and leaves surfaces at 25 ± 2 ^{o}C.

1-2 Effect of contact time

Knowing the equilibrium time of adsorption systems gives a qualitative and quantitative description of adsorption of a substance on a surface under certain conditions.

The effect of contact time ranged from (5.0-100) min between the adsorbent and adsorbate on the removal of the metal ions was determined by keeping pH, temperature, weight and initial concentration constant. The rate of uptake of metal ion was quite rapid, 35 and 45 min. for Co(II) and Cu(II) by carbon activated for (fiber and leaves palm) respectively because this time was enough to remove the largest amount of heavy metals used in this experiment.

The Figure shows that the percentages of adsorption generally increase with time until equilibrium time is reached and the two surfaces have different percentages depending on the nature of the physical and chemical surface. This shows why equilibrium values during the initial period were unstable to more than one absorption process (Han et al., 2000).



Figure(2): Effect of contact time on rate of Co(II) and Cu(II) removal by fiber and leaves of palm at 25±2 oC, 0.4 g and pH 6.5.

1-3 Effect of adsorbent weight

The effect of different weight of adsorbents at (0.1, 0.2 , 0.4, 0.6, 0.9 and 1.3 g), for adsorbent were assessed and the percentage of adsorption for different weights was determined by keeping all other factors constant.

The research work aimed to find the amount of adsorbent that is required to attain surface saturation for adsorbent materials at certain conditions (Riaz and Abdul-Hameed, 2002). The experiments were carried out and the results are presented, it is very clear from these Figures that the tested adsorbents doses (0.4g) of adsorbent weight was very ideal to obtain at best adsorption for both Co(II) and Cu(II).

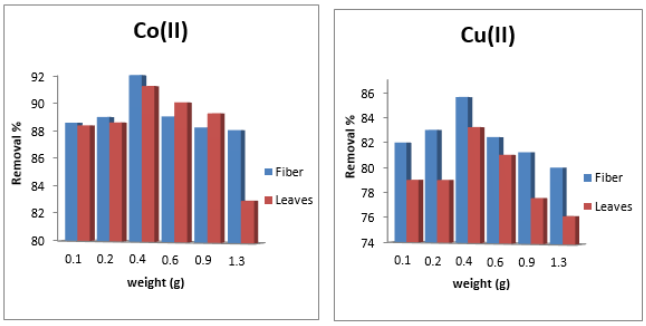


Figure (3) : Effect of the adsorbent weight on rate of Co(II) and Cu(II) removal for the fiber and leaves surfaces at 25 ± 2 oC, pH 6.5 and contact time 35 min.

1-4 Effect of heavy metal initial concentration

This experiment was conducted with heavy metals concentrations which were (6.0, 12, 18 and 24 mg.L-1) with all the factors remaining constant . Which indicate that the percentage removal decreases with the increase in the initial ion concentration, this is because there were no more adsorption sites on the adsorption surface of the adsorbent material (Namasivayam and Kavitha, 2002). The results showed that the maximum removal percentage of Co(II) was 90.6 % by using fiber.

The maximum removal percentage of Cu(II) using leaves palm was 85.2 %. This optimum concentration was used in all experiments, for the rest of the concentrations above 6.0 mg.L-1, the removal ratio decreased with increa Concentration.

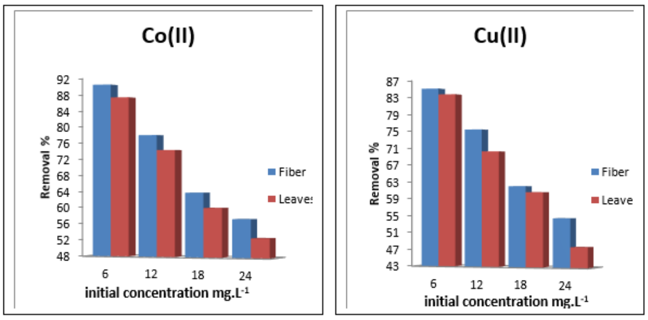


Figure (4) : Effect of heavy metal initial concentration on rate of Co(II) and Cu(II) removal for the fiber and leaves surfaces at 25 ± 2 oC, contact time 35 min and pH 6.5.

1-5 Temperature effect

The adsorption of heavy metals were studied at temperatures of (25, 35, 50 and 60 °C), with all factors remaining constant. The effect of temperature variation on the removal of Co(II) and Cu(II) from an aqueous solution by the fiber and leaves palm. The results showed that the temperature variations would have an influence on the removal of Co(II) and Cu(II) which is decreased with rise in the adsorption temperature. Hence the adsorption process appeared as exothermic (Ray,2006). This means, the low temperatures are the favorite for adsorption of Co(II) and Cu(II) to fiber and leaves palm. Due to the thickness of the boundary layer decreases with the rise in solution temperature, the increased tendency of Co(II) and Cu(II) to escape from the solid phase to the liquid phase, and thus, as a result of an increase in kinetic energy of the adsorbate species at high temperatures, a decrease in adsorption was observed where it was the highest percentage of adsorption at 25 °C.

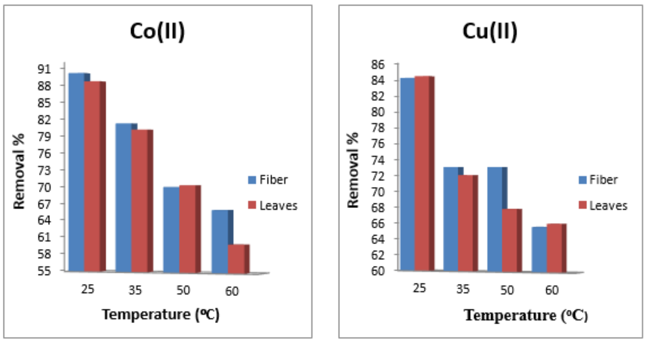


Figure (5): Effect temperature on removal rate of Co (II) and Cu(II) by fiber and leaves palm at 0.4 g, initial concentration 6.0 mg.L-1, pH (6.5) and 35 min.

2- Analysis of samples by FTIR

The analysis was performed by FT-IR for two samples (fiber and leaves palm), samples have been used on form activated carbon. Where the presence of active groups in the samples increases their chemical association with heavy elements and thus increases the possibility of these samples to remove the heavy elements used in the experiment

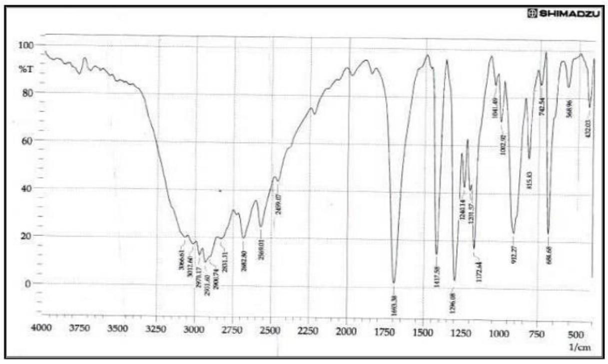


Figure (6): Spectrum FTIR for activated carbon of palm fiber sample.

3- Applications of removal

3-1 Removal of heavy metal from sewage water using adsorbents

The aim of this experiment was to test the ability of adsorbents for the removal of heavy metal from the sewage water , with all the factors remaining constant it's (time, pH, temperature and weight).

The experiment was repeated three times to get accurate results, the Co(II) pollution rate was 1.6 mg.L-1 and Cu(II),1.2 mg.L-1 , there was a decrease in the removal rate due to the presence of other ions in the sewage water that were adsorbed on the surface of the adsorbent material. Thus, the adsorption of activated carbon samples to the Co(II) and Cu(II), will be less.

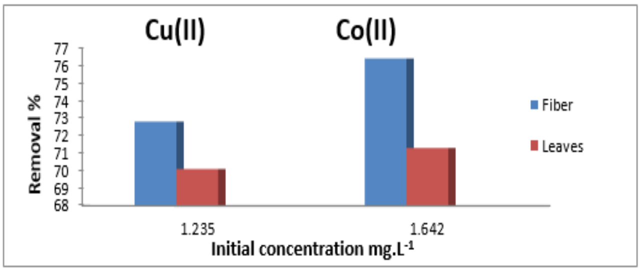


Figure (8): Effect of optimal conditions on rate of Co(II) and Cu(II) of sewage water by fiber and leaves palm at 0.4 g of active carbon pH (6.5), 25±2 oC and contact time 35 min.

V. Conclusion

The existing study shows the prospect of activated carbon samples as a low-cost adsorbent material from residue palm in the removal of Co(II) and Cu(II) from sewage water. The results suggest ability of the adsorbents to adsorption of these metals offered in the following order: Co(II) > Cu(II). Activated carbon samples used can be arranged by more adsorption as follows: fiber > leaves palm.

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