Adsorptive Properties of Coconut Mesocarp on Removal of Cadmium from Cadmium Sulphate Solution and Waste Water

Than Htike[*1], Htay Htay Myint[2], Aye Aye Khaing[3], Tu Tu Wai[4]

Abstract

In the present research, the efficiency of adsorptive properties of coconut mesocarp has been studied. The mesocarp sample was collected from Zegyo market, Mandalay. Three different sizes of mesocarp samples were prepared. The mesocarp sample was used as adsorbent to cadmium sulphate solution. The adsorptive properties of coconut mesocarp samples on heavy toxic metal, (Cd) were determined by using filtration method. The amount of removal of cadmium was determined by volumetric analysis using standard EDTA and xylenol orange as indicator. The removal capacity of cadmium was investigated by using three different sizes and various amount of coconut mesocarp. Therefore, coconut mesocarp can be used as adsorbent for the removal of toxic heavy metal ions from wastewater in terms of low cost, natural and effective alternatives for commercial adsorbent.

Keyword: coconut mesocarp, commercial adsorbent, removal of toxic heavy metals, waste water

Introduction

Water is a common chemical substance that is essential to all forms of life. Availability of water for cleaning is directly to control or eliminate disease. While the world's population tripled in the 20th century, the use of renewable water resources has grown six-fold. Within the next fifty years, the world population will increase by another 40 to 50 %**.** This population growth, coupled with industrialization and urbanization will result in an increasing demand for water and will have serious consequences on the environment (Aye Mat Mon, 2012).

Environmental pollution by toxic metals occurs globally through agrochemical and industrial processes and also through disposal. Metals, discharged into the environment often cause not only large environmental impact but also economic and health problems. Environmental regulations require the removal of heavy metals from wastewater. Today there are many technologies available to reduce the concentration of heavy metals to levels that comply with the regulatory standards (Patterson, J.W., 1985).

Heavy metals are usually present in wastewaters which are released into the environment from various industries. The adverse effects caused by these heavy metals are of great environmental concern. Heavy metals are nonbiodegradable and accumulate in living organisms thereby causing various disease and disorders. Cadmium is commonly found in industrial workplaces. Cadmium is used extensively in electroplating, although the nature of the operation does not generally lead to overexposures. Cadmium is also present in the manufacturing of some types of batteries. Exposures to cadmium are addressed in specific standards for the general industry, shipyard employment, construction industry, and the agricultural industry (Mantell, C.L., 1951).

The use of the coconut shell as a biosorbent material presents strong potential due to its high content of lignin. As a low cost, powder of coconut shell-cocos nucifera is an attractive and inexpensive option for the biosorption removal of dissolve metals. Various metal binding mechanisms are thought to be involved in the biosorption process including ion

[1] Lecturer,Dr., Department of Chemistry, University of Mandalay,
[2] Lecturer,Dr., Department of Chemistry, Yadanabon University
[3] Dr, Lecturer,Dr., Department of Chemistry, University of Mandalay
[4] Lecturer, Dr.,Department of Chemistry, University of Mandalay

exchange, surface adsorption, chemisorption, complexation, and adsorption-complexation (Hnin Lhwar Myint, 2013).

In this research, coconut mesocarp sample was used as adsorbent due to low cost and high efficient performance for adsorption.

Botanical Description

Kindgom	:	Plantae	Tribe	:	Cocoeae
Class	:	Monocots	Genus	:	*Cocos*
Order	:	Arecales	Myanmar name	:	Ohn
Suborder	:	Commelinids	English name	:	coconut
Family name	:	Arecaceae	Botanical name	:	*Cocosnucifera* L.
Subfamily	:	Arecoideae			

Material and Methods

Sample Collection

The coconut shell sample was collected from Zeygo market, Mandalay.

Preparation of Adsorbent

Coconut shells were cut into small pieces and ground with electric grinder. And then, these coconut mesocarp samples were served through 40, 60, 80 and 100 mesh size sieves.

Three different mesh sizes of coconut mesocarp samples such as CM-1 (40 mesh ≥ Coconut mesocarp ≥ 60 mesh), CM-2 (60 mesh ≥ Coconut mesocarp ≥ 80 mesh) and CM-3 (80 mesh ≥ Coconut mesocarp ≥ 100 mesh) were obtained.

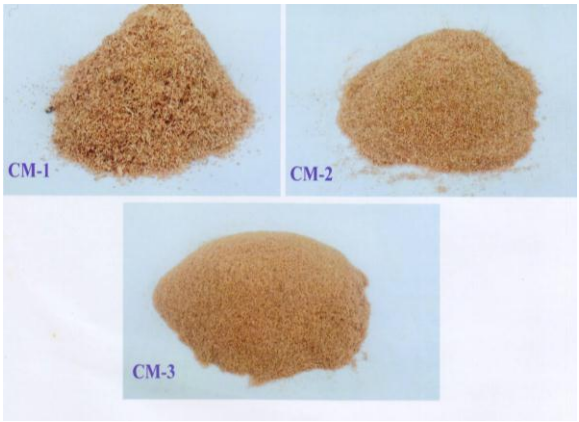

Figure (1) Three Different Mesh Sizes of Coconut Mesocarp Samples

Determination of Adsorptive Properties of Mesocarp Sample (CM-1) by Filtration Method

Sample

(a) Coconut mesocarp sample (CM-1)
(b) Cadmium sulphate solution (0.05 M)
(c) EDTA (0.01 M)
(d) Xylenol orange
(e) Hexamine
(f) Dilute sulphuric acid

Apparatus

(a) measuring cylinder (100 mL)
(b) conical flask (250 mL)
(c) glass tube
(d) burette
(e) beaker
(f) column
(g) micro pipette

Procedure

0.215 g cotton was put in the column (2 cm diameter and 70 cm length). 1 g of coconut mesocarp sample (CM-1) was added over the cotton. Then 0.215 g cotton was put over the sample. 100 mL of cadmium sulphate solution was added into the column. The solution was passed through the adsorbent slowly and steadily along the column at room temperature. The flow rate of the sample was 12 drops per minute. The filtrate was collected until no drop comes out from the column. Three drops of xylenol orange indicator was added into 5 cm^3 of filtrate in a conical flask to obtain wine red colour solution. A few drops of dilute sulphuric acid were added in this solution to obtain yellow colour solution. A small amount of hexamine powder was added in this solution to obtain red colour solution. This prepared solution was titrated with EDTA solution to reach the end point of yellow colour solution.

To know the effect of amount of coconut mesocarp on removal of cadmium, the various amount of adsorbent, coconut mesocarp were used in the range of (1-10) g. The results were shown in Table 1.

The same procedures were performed for the adsorbents (CM-2 and CM-3).

Determination of Toxic Metal (Cd) Removal Capacity of Coconut Mesocarp for the Waste Water

To apply the mesocarp as adsorbent for the removal of metals from waste water, the waste water was collected from Shwe-Ta-Chaung. The smallest size of mesocarp sample (CM-3) was chosen. The use of the amount of CM-3 sample was 10 g. The same procedure was performed. In this procedure, the waste water was used instead of cadmium sulphate solution.

Results and Discussions

Determination of Cadmium Removal Capacity of Coconut Mesocarp

To determine the cadmium removal capacity, three kinds of coconut mesocarp were used as adsorbent and filtration method was used.

Cadmium removal capacity of various amount of three different mesh sizes coconut mesocarp samples were determined for cadmium sulphate solution and waste water the results were described in Table 1, 2, 3 and 4.

Table 1. Percent Removal of Cadmium by Mesocarp (CM-1) Sample from Cadmium Sulphate Solution

No.	wt. of coconut mesocarp (CM-1) (g)	Initial weight of cadmium (mg)	Remaining weight of cadmium (mg)	Removal weight of cadmium (mg)	Percent removal of cadmium (%)
1.	1	78.694	61.831	16.863	21.4285
2.	2	78.694	55.6479	23.0461	29.2857
3.	3	78.694	50.0269	28.6671	36.4285
4.	4	78.694	42.1575	36.5365	46.4285
5.	5	78.694	37.0986	41.5954	52.8571
6.	6	78.694	32.6018	46.0922	58.5714
7.	7	78.694	26.4187	52.2753	66.4285
8.	8	78.694	20.7977	57.8963	73.5714
9.	9	78.694	15.7388	62.9552	80.000
10.	10	78.694	11.242	67.452	85.7142

According to this table, weight of coconut mesocarp sample increased, the percent removal of cadmium also increased.

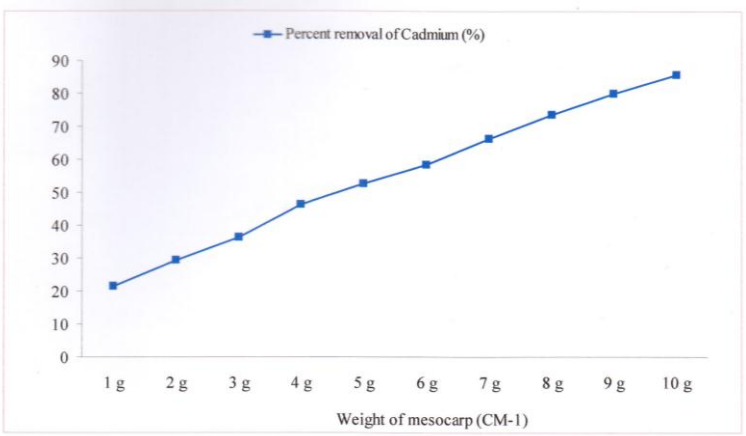

Figure 2. The Plot of Percent Removal of Cadmium by using Various Weights of Mesocarp (CM-1) Sample

Table 2. Percent Removal of Cadmium by Mesocarp (CM-2) Sample from Cadmium Sulphate Solution

No.	wt. of coconut mesocarp (CM-2) (g)	Initial weight of cadmium (mg)	Remaining weight of cadmium (mg)	Removal weight of cadmium (mg)	Percent removal of cadmium (%)
1.	1	78.694	54.5237	24.1703	30.7142
2.	2	78.694	47.7785	30.9155	39.2857
3.	3	78.694	42.7196	35.9744	42.7142
4.	4	78.694	36.5365	42.1575	53.5714
5.	5	78.694	31.4776	47.2164	60.000
6.	6	78.694	26.9808	51.7132	65.7142
7.	7	78.694	21.9219	56.7721	72.1428
8.	8	78.694	16.863	61.831	78.5714
9.	9	78.694	12.9283	65.7657	83.5737
10.	10	78.694	7.3073	71.3867	90.7142

According to this table, weight of coconut mesocarp sample increased, the percent removal of cadmium also increased.

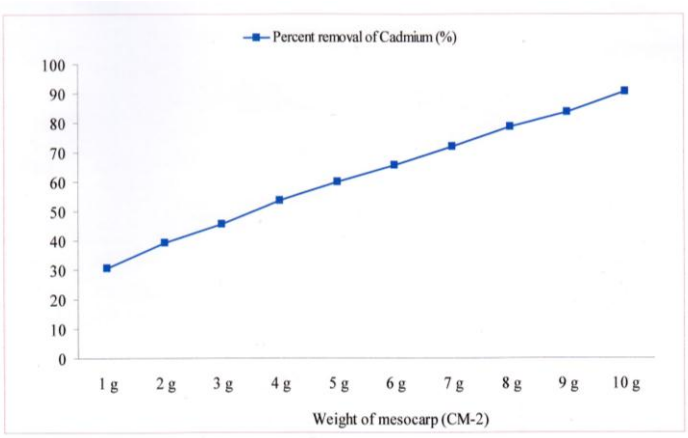

Figure 3. The Plot of Percent Removal of Cadmium by using Various Weights of Mesocarp (CM-2) Sample

Table 3. Percent Removal of Cadmium by Mesocarp (CM-3) Sample from Cadmium Sulphate Solution

No.	wt. of coconut mesocarp (CM-3) (g)	Initial weight of cadmium (mg)	Remaining weight of cadmium (mg)	Removal weight of cadmium (mg)	Percent removal of cadmium (%)
1.	1	78.694	41.5954	37.0986	47.1428
2.	2	78.694	37.6607	41.0333	52.1428
3.	3	78.694	30.9155	47.7785	60.7142
4.	4	78.694	25.2945	53.3995	67.8571
5.	5	78.694	21.9219	56.7721	72.1428
6.	6	78.694	16.3009	62.3931	79.2857
7.	7	78.694	11.242	67.452	85.7142
8.	8	78.694	7.8694	70.8246	90.00
9.	9	78.694	4.4968	74.1972	94.2857
10.	10	78.694	1.6863	77.0077	97.8571

According to this table, weight of coconut mesocarp sample increased, the percent removal of cadmium also increased.

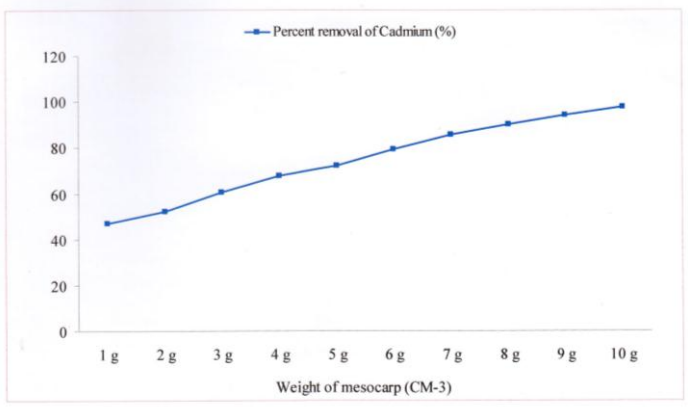

Figure 4. The Plot of Percent Removal of Cadmium by using Various Weights of Mesocarp (CM-3) Sample

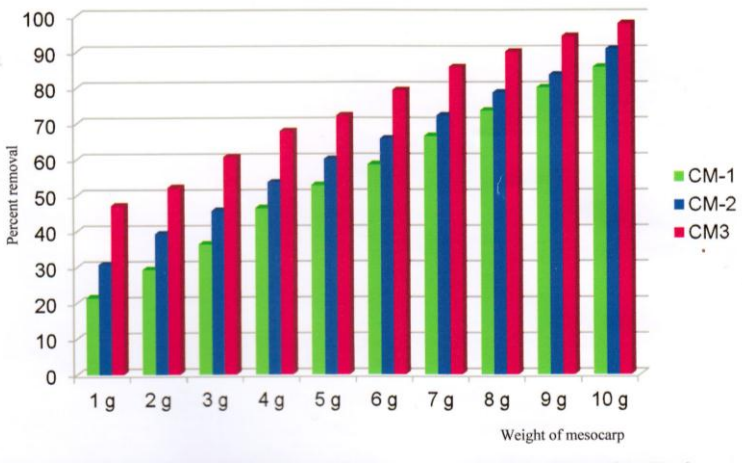

Figure 5. The Histogram of Percent Removal of Cadmium by Using Various Weights of Three Different Sizes of Mesocarp Samples

According to this diagram, the smaller the size of coconut mesocarp sample, the greater the removal of cadmium.

Table 4. Percent Removal of Toxic Metals (Cd) by Mesocarp (CM-3) Sample from Waste Water

No.	wt. of mesocarp (CM-3) sample (g)	Initial weight of Toxic metals (Cd) (mg)	Remaining weight of Toxic metals (Cd) (mg)	Removal weight of Toxic metals (Cd) (mg)	Percent removal of Toxic metals (Cd) (%)
1	10	44.968	14.0525	30.9155	68.75
2	10	44.968	14.6146	30.3534	67.50
3	10	44.968	13.4904	31.4776	70.00

According to this table, the percent removal of toxic metals (Cd) from waste water by mesocarp (CM-3) was found to be 67.50-70.00 %.

Conclusion

The coconut mesocarp sample was collected from Zegyo market, Mandalay. Three different sizes of coconut mesocarp samples CM-1 (40 mesh ≥ Coconut mesocarp ≥ 60 mesh), CM-2 (60 mesh ≥ Coconut mesocarp ≥ 80 mesh) and CM-3 (80 mesh ≥ Coconut mesocarp ≥ 100 mesh) were prepared. The adsorption of cadmium has been carried out in cadmium sulphate solution and waste water by coconut mesocarp at various weights by using complexometric titration. It was observed that the percent removal increases with increasing the weight of coconut mesocarp. From the comparative studies of percent removal of cadmium, it can be seen that, the adsorptive power of smaller size of the coconut mesocarp (CM-3) is better than that of larger two (CM-1 and CM-2). As an application, the removal of toxic metals (Cd) from waste water was found to be 67.50 – 70.00 % by using coconut mesocarp (CM-3). Therefore, coconut mesocarp can be used as adsorbent for the removal of toxic heavy metal ions (Cd^{2+}) from wastewater in terms of low cost, natural and effective alternatives for commercial adsorbents.

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