Removal of Lead from Lead II Nitrate Solution Using Coconut Mesocarp

Than Htike[1], Htay Htay Myint[2], Aye Aye Khaing[3]

Abstract

In the research work, the efficiency of adsorptive properties of coconut mesocarp have 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 lead (II) nitrate solution. The adsorptive properties of coconut mesocarp samples on heavy toxic metal, (Pb) were determined by using filtration method. The amount of removal of lead was determined by volumetric analysis using standard EDTA and xylenol orange as indicator. The removal capacity of lead 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 term of low cost, natural and effective alternatives for commercial adsorbent.

Keyword: coconut mesocarp, adsorptive properties, removal of toxic metals

Introduction

Water is a common chemical substance that is essential to all known forms of life. Availability of water for cleaning directly controls or eliminates diseases. While the world's population becomes 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 (Ng, J.C.Y, Cheung, W.H., and Mockoy, G., 2003).

Environmental pollution by toxic metals occurs globally through agrochemical and industrial processes, and disposal. Metals, discharged into the environment often not only cause 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 non-biodegradable and accumulate in living organisms, thereby causing various disease and disorders (Bailey *et at.*, 1999).

Lead is often found in wastewater from printed circuit board factories, electronic assembly plant, battery recycling plants and land fill leachate. In the printed circuit factory, solder planting and etching operations is the lead source. In the electronic assembly operations, the source is solder flux cleaning. In battery breaking, the lead is found in the sulfuric acid from the battery.

The use of the coconut shell as a biosorbent material presents strong potential due to its high content of lignin, around 23-43 % (Carrijo *et at.*, 2002). 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

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

mechanisms are thought to be involved in the biosorption process including ion exchange, surface adsorption, chemisorption, complexation, and adsorption-complexation (Pino, 2005 Matheickal *et al.*, 1999).

Coconut shell is predominately microporous and is well suited for organic chemical adsorption, including volatile organic chemicals while having higher chlorine reduction capabilities. The main techniques used for metals removal include chemical precipitation, electrolytic and membrane processes, ion exchange and adsorption (Hnin Lhwar Myint, 2013).

Adsorption is an efficient separation process that can selectively and effectively remove adsorbates from a liquid phase onto a solid phase (sorbent). The technical utilization of the adsorption-absorption (sorption) phenomena mainly depends on the availability of suitable and cheap adsorbents (Mantell, C.L., 1951). Pollution is one aspect of the broader topics of environmental tissues. Various forms of pollution caused widespread environmental and health problems.

Increased sensitivities to lead and other pollution are resulting in stiffening of the relevant mandatory environmental standards. Effective lead pollution control system is a necessity for sustainable business operations. Well-designed solutions enable economically viable compliance with regulations while contributing to proper occupational safety and health levels (Aye Myat Mon, 2012).

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

Aim and Objectives

Aim

The aim of this research is to study the removal of lead from lead II nitrate solution using coconut mesocarp.

The objectives are

- to collect the coconut mesocarp sample
- to prepare the different sizes of coconut mesocarp
- to study the adsorptive properties of coconut mesocarp from lead II nitrate solution

Botanical Description

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

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 grinded 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 ≥ Coconut mesocarp ≥ 60 mesh), CM-2 (60 mesh ≥ Coconut mesocarp ≥ 80 mesh) and CM-3 (80 mesh ≥ Coconut mesocarp ≥ 100 mesh) were obtained.

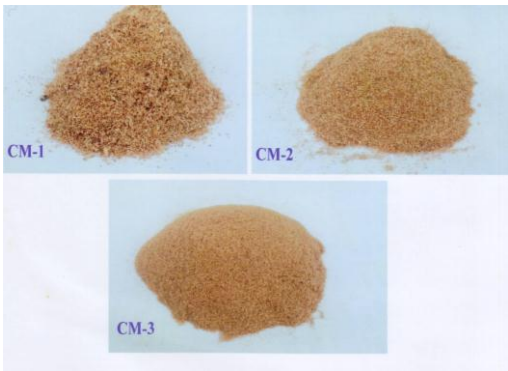

Figure (1) Three Different Mesh Sizes of Coconut Mesocarp Samples

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

Sample

(a) Coconut mesocarp sample (CM-1)
(b) Lead II nitrate solution (0.05 M)
(c) EDTA (0.01 M)
(d) Xylenol orange
(e) Hexamine
(f) Dilute nitric 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 7 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 lead II nitrate 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 nitric 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 lead, the various amounts 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).

Calculation

The removal of lead can be calculated from the following formula.

1 mL (0.01 M) EDTA = 10.3605 mg Pb

(x) mL (0.01M) EDTA = ?

$$= \frac{(x)\ \text{mL}\ (0.01\ \text{M})\ ´\ 10.3605\ \text{mg}}{1\ \text{mL}\ (0.01\ \text{M})} = (y)\ \text{mg}$$

x = volume of EDTA used, y = weight of lead

Results and Discussions

Determination of Lead Removal Capacity of Coconut Mesocarp

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

Lead removal capacity of various amount of three different mesh sizes coconut mesocarp samples were determined for lead II nitrate solution and the results were described in Table 1, 2 and 3.

Table 1. Percent Removal of Lead by Mesocarp (CM-1) Sample from Lead Compound Containing Water

No.	wt. of coconut mesocarp (CM-1) (g)	Initial weight of lead (mg)	Remaining weight of lead (mg)	Removal weight of lead (mg)	Percent removal of lead (%)
1.	1	60.5053	59.8837	0.6216	1.0274
2.	2	60.5053	54.4962	6.0091	9.9315
3.	3	60.5053	53.6674	6.8379	11.3014
4.	4	60.5053	50.3520	10.1533	16.7808
5.	5	60.5053	43.0997	17.4056	28.7671
6.	6	60.5053	34.4008	26.1085	43.1507
7.	7	60.5053	29.4238	31.0815	51.3699
8.	8	60.5053	18.6489	41.8564	69.1781
9.	9	60.5053	13.6758	46.8295	77.3973
10.	10	60.5053	10.5677	49.9376	82.5343

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

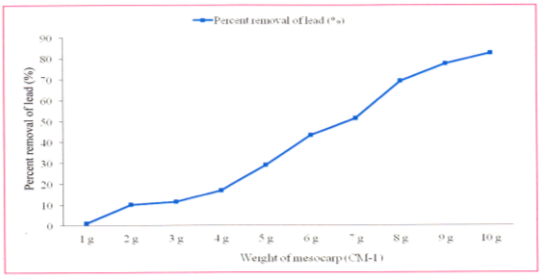

Figure 2. The Plot of Percent Removal of Lead by using Various Weights of Mesocarp (CM-1) Sample

Table 2. Percent Removal of Lead by Mesocarp (CM-2) Sample from Lead Compound Containing Water

No.	wt. of coconut mesocarp (CM-2) (g)	Initial weight of lead (mg)	Remaining weight of lead (mg)	Removal weight of lead (mg)	Percent removal of lead (%)
1.	1	60.5053	58.6404	1.8649	3.0822
2.	2	60.5053	53.8745	6.6308	10.9590
3.	3	60.5053	52.0096	8.4957	14.0412
4.	4	60.5053	48.2799	12.2254	20.2055
5.	5	60.5053	41.0275	19.4778	32.1918
6.	6	60.5053	32.5319	27.9734	46.2329
7.	7	60.5053	28.3877	32.1176	53.0823
8.	8	60.5053	15.5408	44.9645	74.3149
9.	9	60.5053	12.847	47.6583	78.7671
10.	10	60.5053	9.3245	51.1808	84.5889

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

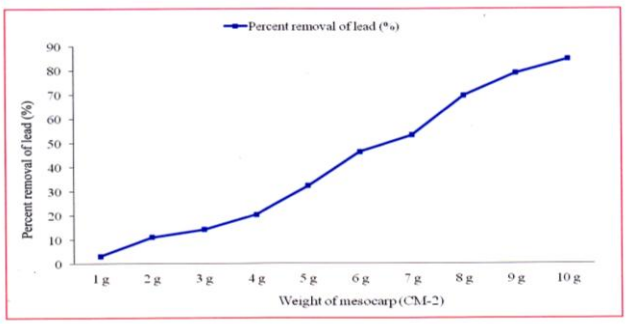

Figure 3. The Plot of Percent Removal of Lead by using Various Weights of Mesocarp (CM-2) Sample

Table 3. Percent Removal of Lead By Mesocarp (CM-3) Sample From Lead Compound Containing Water

No.	wt. of coconut mesocarp (CM-3) (g)	Initial weight of lead (mg)	Remaining weight of lead (mg)	Removal weight of lead (mg)	Percent removal of lead (%)
1.	1	60.5053	58.0187	2.4866	4.1096
2.	2	60.5053	53.6673	6.8380	11.3014
3.	3	60.5053	51.5952	8.9101	14.7260
4.	4	60.5053	47.8654	12.6399	20.8904
5.	5	60.5053	39.9915	20.5138	33.9041
6.	6	60.5053	31.0814	29.4239	48.6302
7.	7	60.5053	27.5589	32.9464	54.4521
8.	8	60.5053	14.5047	46.0006	76.0274
9.	9	60.5053	12.0181	48.4872	80.1370
10.	10	60.5053	7.2524	53.2529	88.0136

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

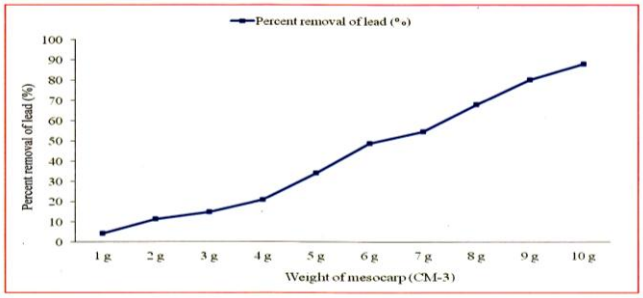

Figure 4. The Plot of Percent Removal of Lead by using Various Weights of Mesocarp (CM-3) Sample

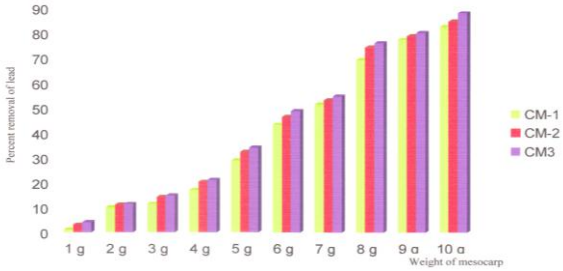

Figure 5. The Histogram of Percent Removal of Lead by Using Various Weight of Three Different Sizes of Mesocarp Samples

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

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 lead has been carried out in lead II nitrate solution 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 lead, 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). Therefore, coconut mesocarp can be used as adsorbent for the removal of toxic heavy metal ions from wastewater in term of low cost, natural and effective alternatives for commercial adsorbents.

References

1. Aye Myat Mon, (2012), "The Optimum Condition for the Adsorption of Cr (VI) Solution by Using Coconut Shells", MSc (Thesis), Department of Chemistry, Yadanabon University.
2. Hnin Lhwar Myint, (2013), "To Prepare and Characterize Coconut Shell Carbon", MSc (Thesis), Department of Chemistry, Yadanabon University.
3. Mantell, C.L. (1951), Adsorption (Chemical Engineering Series), PhD. 2 ed.,
4. Ng, J.C.Y, Cheung, W.H, and Mckoy, G., (2003), "Equilibrium Studies for the sorption of lead from Effluents using chitoson". Chemosphere, vol. *52:* 1021-1030.
5. Patterson, J.W., *(1985),* "Industrial Wastewater Treatment Technology", Balterworth Publishers Stoneham, MA, P. 218.