IOSR Journal of Pharmacy and Biological Sciences (IOSR-JPBS)
e-ISSN: 2278-3008, p-ISSN:2319-7676. Volume 9, Issue 6 Ver. III (Nov -Dec. 2014), PP 97-99
www.iosrjournals.org

Sorption and Removal of Pb^{+2} Ions from Aqueous Environment Using Okra Stem Derived Cellulose Material

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Abstract: *The removal of Pb^{2+} ions from aqueous environment using okra derived cellulose biomass has been investigated. Percent sorption of Pb^{2+} ions in waste water decreased with increase in concentration of Pb^{+2} in waste water but increased with increase in adsorbent weight of the biomass. Percent sorption of Pb^{2+} is time dependent; showing a maximum at 10 minutes contact time.*
Keywords: *Okra derived biomass, pb^{2+} ions*

I. Introduction

A particular class of compounds of major concern the world over is the presence of heavy metals in aqueous media. The rate at which heavy metal bearing effluents are discharged into the environment and water bodies has been on the increase due to rapid industrialization (Okoye et al., 2010). A recent focus on the removal of metal ions from solution is the use of agricultural materials through adsorption. Heavy metals could be defined as those chemical elements with a specific gravity that is at least five times the specific gravity of water at 4 °C (39 °F). Heavy metals become toxic when they are not metabolized by the body and accumulate in the soft tissues. They may enter the body through food, water, air adsorption and through the skin.

Lead is number 2 on the ATSR'S Top 20 list and accounts for most of the cases of paediatric heavy metal poisoning (Roberts, 1999). It is a very soft metal and was used in pipes, drains and soldering materials for many years. Millions of homes built before 1940 still contain lead in painted surfaces. Every year, industry produces about 2.5 million tons of lead throughout the world. Most of these lead is used for battery. The remainder is used for cable coverings, plumbing, ammunition and fuel additives. Other uses are as paint pigments and in PVC plastics, X-ray shielding, crystal glass production and pesticides. The target organs are the bones, brain, blood, kidneys and thyroid gland. The use of Agricultural materials for the removal of toxic metals have become more attractive now because their easy availability, low cost and biodegradability. In these days of green environment they are preferable choice compared to the conventional adsorbents like charcoal, activated carbon and zeolite (4, 5, 6) especially on account of their biodegradability.

II. Materials And Methods

Sample Collection: Okra stems were collected from Michael Okpara University of Agriculture, Experimental Farm Unit. The okra stems were identified by a botanist, Dr. Garuba Omosun of the Botany Department of the same University. All chemical reagents were analar grades from the BDH London. They were used without further purification.

Sample Preparation: Okra stem were air dried, milled and grounded into powder using milling machine (Binatone model). The powdered sample was sieved using 2mm sieve to obtain a fine powder. The okra stem fine powder was converted into cellulose pulp using alkaline pulp `method (Clark, 1985). The okra stem derived cellulose pulp was dried and sieved using 2mm sieve.

Synthetic Waste Water Preparation: Two hundred and seven gram of lead II nitrate was weighed out and dissolved in a litre of distilled deionized water to obtain one molar solution of Pb^{2+} ion solution. From this stock, $4cm^3$ was diluted to one litre mark with distilled deionized water to obtain 250ppm Pb^{2+} ion solution used in the kinetic studies.

Adsorption Studies: Effect of contact on Pb^{2+} ion adsorption by okra stem derived cellulose pulp were carried out in a simulated Pb^{2+} ion contaminated water using 10ml of the synthetic water solution which contains 250 ppm Pb^{2+} ion. Seven clean labeled separation flasks were set up. 10ml of the synthetic waste water was measured and added to each flask. Point one gram of the fine okra derived cellulose pulp was weighed out and added to each flask, shaken gently to achieve through mixing. The adsorption process was monitored for each of the flask at a time interval of 5, 10, 15, 20, 25, 30 and 35 minutes respectively for each of the seven flasks serially. At the end of each specified contact time, the content of each flask was decanted by filtration. 10ml of each filtrate from individual flask was taken into clean labeled reagent bottle for AAS analysis of the unsorbed Pb^{2+} ion sorbed in the waste water.

The amount of Pb^{2+} ion sorbed by okra stem derived cellulose pulp at each specified contact time was the difference between the initial concentration of the Pb^{2+} ion in the synthetic waste and the unsorbed Pb^{2+} as determined by AAS absorption (Abia et al., 2002). A hollow cathode lamp containing Pb^{2+} was used.
Thus $C_0 - C_{unsorbed} = C_{sorbed}$
Where C_0 = Initial concentration of the Pb^{2+} ion.

The concentration studies and competitive concentration studies were also carried out using the same procedure as described above (Okoro and Chidiadi, 2011, Okorie and Ikenna, 2014).

III. Results And Discussion

The various factors affecting the sorption of Pb^{2+} from aqueous water, waters using Okra (Abelmochus esculentus) stem derived pulp as adsorbent were investigated and the results are presented in the tables below.

Percent sorption decreased with increase in the concentration of Pb^{2+} in the aqueous waste water solution. This may be due to the saturation of the pores in the cellulose by the Pb^{2+} as its concentration increases. This observation is in agreement with most agricultural materials that have been used as biomaterials due to their cellulosic nature.

The result of the contact time investigation or Table 3 shows that the biomaterial sorbed more than ninety-nine percent of the Pb^{2+} present in the aqueous waste water. The maximum sorption time occurred at 10 minutes contact time and there after the saturation time limit set in with decreasing amount of Pb^{2+} being sorbed with increasing contact time.

Table 2 shows that percent sorption increases with increase in absorbent weight at constant waste water Pb^{2+} concentration. This is understandably so due to increase in absorptive sites of the adsorbents with increase in weight. The maximum limit of Pb^{2+} in water bodies does not exceed 0.005 ppm. The removal of more than 99% of initial concentration of Pb^{2+} is highly significant. The okra stem derived cellulose pulp is therefore strongly recommended as an alternative material for the removal of excess Pb^{2+} from water bodies as well as waster waters. There is also the ease of recovery, biodegradability and easy, availability of the adsorbents such as zeolites activated carbon and alumina. The cellulose pulp is mainly composed of lingo-cellulose materials having relatively large surface areas that can provide intrinsic adsorptive sites for Pb^{2+}.

Percent sorption increased with concentration of Pb^{2+} ions present in synthetic waste water to a maximum at 20mg/L and began to decline. This saturation at 20mg/L Pb^{2+} ions in waste water is due to the presence of competing ions whose effect declined at higher concentrations. The percent sorption is heavily dependent on the absorbent weight. Thus the use of higher absorbent weight is recommended for the removal of Pb^{2+} ions using okra derived cellulose pulp for the removal of Pb^{+2} from aqueous environment.

As would be expected, percent sorption of Pb^{2+} ions from aqueous solution is time dependent; getting at the maximum at 10 minutes contact time and later on began to decline steadily.

Table 1: Effect of Concentration on the sorption capacity of Okra derived cellulose for Pb^{2+}

Initial Wt of absorbent	Concentration (mg/L)	Amount sorbed (mg/L)	% Sorption
0.10	10.00	8.831	88.31
0.10	20.00	16.489	82.45
0.10	30.00	22.929	76.43
0.10	40.00	32.14	80.35

Table 2: Effect of Absorbent weight on the sorption capacity of Okra derived cellulose pulp for Pb^{2+}

Initial Wt of absorbent	Concentration (mg/L)	Amount sorbed (mg/L)	% Sorption
10.00	0.10	8.291	82.91
10.00	0.20	8.691	96.91
10.00	0.30	9.335	93.35
10.00	0.40	9.793	97.93

Table 3: Effect of time on the sorption capacity of Okra derived cellulose pulp for Pb^{2+}

Initial Concentration (mg/L)	Time (mins)	Amount sorbed (mg/L)	% Sorption
10.00	5	9.87	98.70
10.00	10	9.99	99.90
10.00	15	8.986	89.86
10.00	20	8.48	84.80
10.00	25	8.06	8.60
10.00	30	8.04	80.40
10.00	35	7.76	77.60

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