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RESEARCH ARTICLE

The Use of Okra Derived Cellulose Biomass for the Removal and Recovery of Cd and Pb Ions from the Aqueous Environment

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Abstract: The use of okra derived cellulose biomass for the removal and recovery of Cd and Pb ions from aqueous environment was investigated. The results showed that more than ninety eight percent of each Cd and Pb ions was removed from the synthetic wastewater, the okra derived cellulose biomass showed mass and concentration dependent. The okra derived cellulose biomass depicted saturation behavior as well as time dependent curve.

Keywords: Cd ion, Pb ion, Okra derived cellulose, Biomass, Synthetic waste water

Introduction

The use of biodegradable materials for removal of toxic metal ions from wastewater and aqueous environment is the modern society is based on the concern for environment. This is based on the concept of green environment and most developed as well as the emerging countries are going green.

This going green trend is the environmental consciousness arises from realization that our attitude will determine the future of this planet (CNN 2012). The conventional adsorbent materials such charcoals, activated carbon zeolites, silica gel G, among others are not biodegradable[1-4]. This is the basis of the use biodegradable adsorbents like saw dust, yam peels, cassava peels, banana peels, coconut fibers, okra derived cellulose[5-7]. The two toxic metal ions; Cd ion and Pb ion such is the subject of this study are metal ions without biological roles and are listed as priority pollutants[2,5]. The two toxic metal ions no longer have permissible limits, they are not need in any amount in the aqueous environment and in consumables[5-8].

Experimental

Okra stems were collected from Michael Okpara University of Agriculture Umudike experimental farm center, okra stems were identified by a Botanist Dr, Omosun Garuba of plant science and biotechnology department of the same university. All chemical reagents were analytical grades from BDH Chemicals, London.

Sample preparation

Okra stems were air-dried, milled and ground into powder using milling machine (biatone model). The powdered samples were sieved into fine powder using 2 mm sieve. The fine powdered okra stems were converted into cellulose pulp by alkaline pulping method[8]. Okra derived cellulose pulp was dried and sieved into fine powder.

Synthetic wastewater preparation:

136.9 g of lead acetate were weighed out and dissolved in 1 liter of deionised water to form the stock solution. From this stock solution, 10 mL was measured out into one liter volumetric flask and diluted in one liter mark with distilled deionised water to obtain equivalent of 100 ppm Pb(II) ion solution. A similar preparation procedure was used to obtain 100 ppm Cd(II) using cadmium chloride as starting reagent. Equimolar solution mixture containing Cd, Pb, Fe and Cu ions prepared using various salts of each metal ion. Both 100 ppm Cd(II) ion solution and 100 ppm Pb(II) ion solution, 100 ppm of the mixture respectively were each used for the contact time, concentrations and competitive adsorption studies carried out using the okra derived cellulose biomass as adsorbents.

Adsorption studies

The effect of contact time, concentrations, competitive sorption on adsorption of Cd and Pb ions were each investigated using okra derived cellulose biomass as the adsorbent materials. The Cd ion contaminated synthetic wastewater and Pb ion contaminated synthetic wastewater prepared were each used for the sorption studies carried out. Five clean conical flasks each labeled were setup, 10 mL of Cd(II) ion each were measured out into labeled flask and 100 mg of okra derived cellulose biomass added to each and allowed contact time of 5, 10, 15, 20, 25 and 30 minutes intervals respectively for each flask. At the end of time interval the flask content was filtered and 10 mL of each filtrates transferred into a labeled reagent bottle for AAS Analysis. This same procedure described was repeated exactly using the prepared Pb(II) ion. Varying concentrations of each Cd and Pb ion solution on the sorption behavior of okra derived cellulose biomass were also studied; Competitive sorption using mixture of Cd, Pb, Fe and Cu ions for Cd and Pb each was studied as well.

Atomic absorption photometric analysis

Each filterate collected was analysed for unsorbed Cd(II) using AAS instrument (Unicam model 969) at maximum wavelength of absorption of 229 nm. The difference between the initial concentration of Cd ion and amount of Cd ion in filterate gives the amount of Cd ion sorbed. A similar procedure was used for Pb ion at maximum wavelength of 283 nm. A hollow cathode lamp containing Cd and another hollow cathode lamp containing Pb were each used respectively during the AAS analysis[9].

Results and Discussion

The results of the sorption studies are presented in Tables 1-6, respectively for Cd and Pb ions.

Table 1. Effect of contact time on the sorption capacity of okra derived cellulose for Cd(II) ion

Initial concentration of Cd ion ppm	Contact time in minutes	Amount of Cd ion sorbed in ppm	% Sorption
10.00	5.00	3.632	36.32
10.00	10.00	5.764	57.64
10.00	15.00	5.820	58.20
10.00	20.00	5.915	59.15
10.00	25. 00	5.976	59.76
10.00	30.00	6.829	68.29
10.00	35.00	6.2709	62.71

Values are means of four determinations

Table 2. Effect of contact time on the sorption capacity of okra derived cellulose for Pb(II) ion

Initial concentration of Pb ion ppm	Contact time in minutes	Amount of Pb ion sorbed in ppm	% Sorption
10.00	5.00	9.873	98.73
10.00	10.00	9.996	99.96
10.00	15.00	8.986	89.86
10.00	20.00	8.484	84.48
10.00	25.00	8.056	80.56
10.00	30.00	8.037	80.37
10.00	35.00	7.7569	77.57

Values are means of four determinations

Table 3. Effect of concentrations on sorption capacity of okra derived cellulose biomass for Cd ion

Varying concentrations of Cd ion ppm	Contact time in minutes	Amount of Cd ion sorbed in ppm	% Sorption
10,00	10.00	7.1165	71,165
20.00	10.00	12,578	62.940
30.00	10.00	12.317	41,036
40.00	10.00	11.756	29,406

Values are means of four determinations

Table 4. Effect of concentrations on sorption capacity of okra derived cellulose biomass for Pb ion

Varying concentrations of Pb ion ppm	Contact time in minutes	Amount of Pb ion sorbed in ppm	% Sorption
10,00	10.00	8.8316	88.32
20.00	10.00	16.719	83.60
30.00	10.00	22.929	76.43
40.00	10.00	22.146	74.35

Values are means of four determinations

Table 5. Selective adsorption of Cd ion from the mixture of Cd Pb, Fe and Cu ions using okra derived cellulose biomass

Initial concentration of Cd ion ppm	Contact time in minutes	Amount of Cd ion sorbed in ppm	% Sorption
10.00	5.00	9,569	95.69
10.00	10.00	9.547	95.47
10.00	15.00	9.537	95.37
10.00	20.00	8.937	89.37
10.00	25. 00	8.863	88.63
10.00	30.00	7.872	78.72

Values are means of four determinations

Table 6. Selective adsorption of Pb ion from the mixture of Cd Pb, Fe and Cu ions using okra derived cellulose biomass

Initial concentration of Cd ion ppm	Contact time in minutes	Amount of Cd ion sorbed in ppm	% Sorption
10.00	5.00	8.882	88.82
10.00	10.00	8.864	88.64
10.00	15.00	8.859	88.59
10.00	20.00	8.764	87.64
10.00	25. 00	8.568	85.68
10.00	30.00	7.986	79.86

Values are means of four determinations

From Table 1, it was observed that more than 66% of Cd ion was from the synthetic wastewater and from Table 2, it was observed that more than 96% of the Pb ion was sorbed from the synthetic wastewater studied. From Tables 3 and 4 it was observed that the appropriate concentration as initial metal ion concentration in the wastewater is 10 ppm at which more than 70% and 85% of the Cd and Pb ion respectively each was removed from the aqueous environment. Tables 5 and 6 depicted the selective removal of Cd and Pb ion each from mixture containing other metal ions. The selectivity of the okra derived cellulose biomass for each of these two metal ions Cd and Pb were significantly high. This study has demonstrated that the okra derived cellulose biomass is suitable for use in the removal of Cd and Pb ions from the aqueous environment. It is highly biodegradable, cost little or nothing, readily available and in most cities in developing world constitutes an agricultural waste. Therefore; the use of okra derived cellulose biomass in the removal of these toxic metal ions from the aqueous environment is in agreement with the green chemistry and technology in vogue. It is a good waste to wealth management concept.

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