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Adsorption of Cd^{2+} and Pb^{2+} on Agricultural Byproducts

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Adsorption of toxic metal ions like Cd^{2+} and Pb^{2+} on different vegetable and agricultural byproducts were measured at room temperature by atomic absorption spectrophotometric (AAS) and differential pulse polarography (DPP) methods. The adsorption of Cd^{2+} follows the order polymerised onion skin > bagasse > banana husk > suffola husk > spinach; whereas the adsorption of Pb^{2+} follows the order polymerised onion skin > spinach > suffolahusk > bagasse > banana husk. Polymerised onion skin shows maximum adsorbing capacity for both the ions compared to other adsorbents. The adsorption due to raw onion skin is almost equal to polymerised onion skin. Therefore it can be suggested that raw onion skin is a better substitute for polymerised onion skin. Also the raw onion skin would be a more inexpensive adsorbent than the one modified by a polymer.

INTRODUCTION

The presence of toxic metal ions like cadmium, lead, mercury in industrial waste has attracted world-wide attention. Several methods which include chemical precipitation, ion exchange, ultrafiltration, electrochemical treatment are suggested for the removal of these metal ions. Few workers have designed methods for the adsorption of these ions by using inexpensive agricultural byproducts[1], tree barks[2–6], peanut skin[7,8], agricultural waste materials[9–11] like rice-straw and paddy husk. We thought of using agricultural byproducts in their natural state. This paper presents our findings on the adsorption of Cd^{2+} and Pb^{2+} by inexpensive vegetable and agricultural byproducts such as spinach, suffola husk, banana husk, bagasse and onion skin. The quantitative estimations of these metal ions before and after adsorption are made by differential pulse polarography (DPP) and atomic absorption spectrophotometer (AAS). Earlier workers[9,10] have mainly used polymerised onion skin for adsopriton of these toxic metal ions. We had undertaken this work to compare the adsorption due to raw onion skin with polymerised onion skin.

EXPERIMENTAL

Banana husk, spinach, onion skin and bagasse were collected, exposed to sunlight for one week. Subsequently they were ground, exposed to sunlight for 24 h and were preserved in plastic bottles with air tight corks. The polymerised

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onion skins were prepared by mixing 160 g of dried onion skin, 168 g of formaldehyde, 3.2 litres of 0.2 N sulphuric acid in glass container and warming at 50°C for 2 h with occasional stirring. The product was filtered and washed with warm water (50°C) till the pH of the filtrate was 4 to 5. The product of polymerised onion skin was dried on a hot plate at about 78°C for few hours. 100, 80, 60, 40, 20, 10 ppm solutions each of lead nitrate and cadmium nitrate were prepared from their respective 1000 ppm solutions. All chemicals were of AnalaR grade.

1 g each of the adsorbents were weighed and placed in different conical flasks. 100 mL of 100 ppm solutions of lead nitrate were added in these flasks, which in turn were corked and shaken in mechanical shaker for 1 h. The solutions were filtered and filtrates were preserved in airtight glass bottles. The concentrations of metal ions before and after adsorption were measured by AAS (Table-1).

TABLE-1

ADSORPTION OF Cd^{2+}/Pb^{2+} IONS ON DIFFERENT AGRICULTURAL-BYPRODUCTS BY EQUILLIBRIUM EXPERIMENT AS SEEN BY AAS

Initial conc. (ppm) of Cd^{2+}/Pb^{2+} is 100

Operating conditions for AAS:

Metal	Maximum current	Wave-length	Slit setting	Gas	Flow	Time	Delay
Cadmium/lead	5.8 mA	228.8	0.3 mm	Air/C_2H_2	65/60	3.0 sec	2.0 sec

Cadmium:

Substrate	Spinach	Suffola husk	Banana husk	Bagasse	Polymerised onion skin
Equilibrium conc.	66.88	62.27	59.41	0.62	0.00
% adsorption	33.12	37.73	40.59	99.38	100 *98
Adsorption mg/g	3.31	3.77	4.05	9.93	10 *9.8

*Estimated by pulse polarography.

Lead:

Equillibrium conc.	12.89	15.69	21.65	17.82	6.46
% adsorption	87.11	84.31	78.35	82.18	93.54 *89.00
Adsorption mg/g	8.71	8.43	7.83	8.21	*8.90

DPP technique was used for the adsorption of Cd^{2+} by polymerised onion skin only. The conditions of the experiment are set out in Table-2.

TABLE-2
ADSORPTION OF Cd^{2+} ON POLYMERISED ONION SKIN BY EQUILIBRIUM EXPERIMENT
(Operating condition of polarograph)

I.R.	0–0	T.C.	10	Pulse amplitude	100
S.P.	2–0	Aq.	Fast	Sensitivity	1
O/P	5–0	X-axis	100	Drop time	0.5
C.C.	5–0	Y-axis	200	Temperature	30°C

Weight of polymerised onion skin 1 g

Height (cm) of C-V curve		Corresponding conc. (ppm.)		Amount adsorbed (ppm)	Percentage adsorption
Before ads.	After ads.	Before ads.	After ads.		
1.4	0.00	10	0.00	10.00	100
2.8	0.20	20	1.30	18.70	93.5
5.5	0.24	40	1.80	38.20	95.5
8.2	0.28	60	1.80	58.20	97.0
11.4	0.38	80	2.60	77.40	96.7
14.0	0.60	100	2.00	98.00	98.0

RESULTS AND DISCUSSION

The results on adsoprtion of Cd^{2+} as observed by AAS and DPP on polymerised onion skin show satisfactory agreement The adsorption by the onion skin is 100% to 95% when the Cd^{2+} concentration was in the range of 20 to 100 ppm (Table-2). One can note from Table-2 that the percentage adsorption of Cd^{2+} ions follows the order polymerised onion skin > baggasse > banana husk > suffola husk > spinach. It is therefore inferred that polymerised onion skin is the best adsorbing agent for Cd^{2+} ions.

As regards the adsorption of Pb^{2+} ions, the percentage adsorption is around 80 for suffola husk, banana husk, bagasse and around 90 for spinach and polymerised onion skin as is evident from Table-1. The percentage adsorption of Pb^{2+} on different adsorbents follow the order polymerised onion skin > spinach > suffalo husk > bagasse > banana husk.

Raw white onion skin was also tried as adsorbent for Cd^{2+}. The percentage adsorption by it was less by 2% than the polymerised onion skin. Similar results were also seen for adsorption of Pb^{2+}. These results show that the adsorption due to onion skin surface itself is significant and the polymer material has not enhanced it. Thus, the raw-white onion skin is an equal substitute for polymerised onion skin and be used in its place because it is inexpensive.

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