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Full Length Research Paper

Studies on dyed coconut *(Cocos nucifera)* pollens for removal of Cu (II) and Zn (II) from aqeoues solution

Agiri, G.O[1]*, Akaranta, O[2] and AjayI, I. O

[1]Industrial Safety and Environmental Engineering Department, Petroleum Training Institute, Effurun, Delta State, Nigeria.

[2]Department of pure and Industrial Chemistry, University of Port Harcourt, Port Harcourt.

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The ability of undyed and dyed coconut pollens to remove Cu(II) and Zn(II) from single ion solutions was been studied. The experiments were carried out using coconut pollens (1.0 g) undyed coconut pollens, UDCP, and dyed coconut pollens, DCPI, DCPII and DCPIII of different particle sizes: 0.40, 0.63 and 0.80 mm, respectively. The amount of Cu(II) adsorbed on UDCP, DCPI, DCPII and DCPIII were 69.20, 97.90, 94.70 and 93.10%, respectively, while that of zinc adsorbed on these adsorbents were 87.15, 98.30, 92.55 and 90.05%, respectively. These results show that dyed coconut pollens is effective in removing Cu(II) and Zn(II) from aqueous solutions.

Key words: Adsorption dynamics, dyed coconut pollen grains, chemisorptions, heavy metals removal.

INTRODUCTION

The utilization of agricultural by-products for removal of heavy metals from aqueous solutions has been on the increase. The main reason is that, agricultural by-products are available at little or no cost and are naturally occurring. Also, they are stable and required no complicated regeneration process, care and maintenance. Metal ion produced and released during industrial activities pose a serious threat to the environment and when present in sufficient quantity, can be harmful to aquatic life and human health. Toxic metals are often discharged as effluent water by number of industrial processes which lead to contamination of fresh water and marine environment (Balkose and Baltacioglu, 1992).

Several studies have been carried on the use of modified agricultural products for adsorption of heavy metal from aqueous solution such as modified chitosan (Saucedo et al., 1993), walnut waste (Randall et al., 1974), peanut skin (Randall et al., 1975,), tea waste (Amir et al., 2005), Cotton (Kumar and Dara, 1982); coffee grounds (Macchi et al., 1986); apple waste (Maranon and Sastre, 1991), wool fibre (Balkose and Baltacioglu, 1992), sunflower stalk (Gang and Weixing, 1988), cotton seed hulls (Marshall and Champagne, 1995), linseed flax straw (Taylor et al., 1994), carboxyl groups found on the walls of dead algae biomass (Gardea-Torresday et al., 1990), powdered activate carbon (Yeh and Thomas, 1995), bark and other cellulosic materials. Recently, great effort has been contributed to develop new adsorbents and improve existing ones like cassava waste (Horsfall et al., 2003) and Chitosan (Karthikeyan et al., 2005)

The objectives of the present study were to produce dyed coconut pollen by dyeing with reactive dyes, determine the suitability of coconut pollen treated with reactive dyes as adsorbents for heavy metals such as copper and zinc, and elucidate the mechanisms of heavy metal adsorption onto the dyed coconut pollen.

*Corresponding author E-mail: otasgiri@yahoo.uk.com.

MATERIALS AND METHODS

Coconut pollens

Coconut pollens utilized for this study were collected from nearby garden and used as raw material. The pollen was sun dried for five days and ground in a manual hand grinding mill. The material thus obtained was sieved through 0.40, 0.63 and 0.80mm (ASTM sieve) and termed as undyed coconut pollen (UDCP). All the chemicals used for the analysis were AnalaR high purity grade and used without further purification. Copper nitrate, zinc sulphate, sodium chloride, hydrochloric acid and so-

Table 1. Experiment data of Cu(ii) adsorption by undyed and dyed coconut pollen grains.

Time (min)	UDCP(0.40 mm)		DCPI (0.40 mm)		DCPII (0.63 mm)		DCPIII (0.80 mm)	
	C_t (Mg/l)	Adsorption (%)	C_t (Mg/l)	Adsorption (%)	C_t (Mg/l)	Adsorption (%)	C_t (Mg/l)	Adsorption (%)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	7.34	61.70	0.62	96.90	1.18	94.10	2.40	88.00
10	6.37	68.15	0.60	97.00	1.16	94.20	1.83	90.85
15	6.16	68.15	0.45	97.75	1.08	94.60	1.80	91.10
20	6.16	69.20	0.44	97.80	1.06	94.70	1.38	93.10
25	6.16	69.20	0.42	97.90	1.06	94.70	1.38	93.10
30	6.16	69.20	0.42	97.90	1.06	94.70	1.38	93.10

Initial concentration of Cu(II) ion = 20 mg/l and adsorbent dose =1.0 g.

Table 2. Experiment data of Zn(ii) adsorption by undyed and dyed coconut pollen grains.

Time (min)	UDCP(0.40 mm)		DCPI (0.40 mm)		DCPII (0.63 mm)		DCPIII (0.80 mm)	
	C_t (Mg/l)	Adsorption (%)	C_t (Mg/l)	Adsorption (%)	C_t (Mg/l)	Adsorption (%)	C_t (Mg/l)	Adsorption (%)
0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
5	2.57	87.15	0.34	98.30	1.49	92.55	1.99	90.05
10	2.58	87.10	0.20	99.00	0.43	97.85	0.95	95.25
15	0.03	88.50	0.17	99.15	0.33	98.35	0.03	99.85
20	2.39	88.50	0.01	99.95	0.04	99.80	0.71	96.45
25	2.28	88.60	0.01	99.95	0.04	99.80	0.71	96.45
30	2.28	88.60	0.01	99.95	0.04	99.80	0.71	96.45

Initial concentration of Zn(II) ion = 20mg/l and adsorbent dose =1.0 g.

dium carbonate were used for the experiments.

The dye utilized for the study was prepared by the method described in earlier studies by Agiri (2006).

Dyeing reaction

About 20 g each of the coconut pollen was dyed with the reactive dye, using the method given by Suemitsu et al. (1986) and labeled as Dyed Coconut Pollen I, II and III (DCPI, DCPII and DCPIII).

Batch adsorption process

The adsorption studies were conducted by placing 1 g of dyed coconut pollen in 250 ml stoppered Erlenmeyer flasks. This was followed by the addition of 50 ml pre-determined metal ion stock solution containing 20 mg/l copper and zinc solutions. The flask was then shaken for a given time interval in vibratory shaker. At the end of the shaking period the solution was filtered through a glass wool at preset time intervals (2 min) and the residual metal ion concentrations were measured using the Buck Scientific Atomic Absorption/Emission Spectrophotometer 200 A.

RESULTS AND DISCUSSION

Effect of contact time

The results of time dependency experiments conducted for the binding of Cu (II) and Zn (II) ions onto undyed and dyed coconut pollen grains are shown on Tables 1 and 2. The overall sorption behaviour of Cu(II) onto the adsorbent was similar with differences in the amounts adsorbed. The amounts of Cu (II) adsorbed per 1 g UDCP, DCPI, DCPII and DCPIII were 61.70, 96.90, 94.10 and 88.00%, respectively, and this increased to 69.20; 97.90; 94.70 and 93.10%, respectively, in 30 min. It can be shown that the adsorption of Cu (II) from aqueous Cu (II) solution on DCP I, II, III is faster than UDCP. The amount of Zn (II) adsorbed onto UDCP, DCPI, DCPII and DCPIII were 87.15, 98.30, 92.55 and 90.05%, respectively, and this increased to 88.60, 99.95, 99.80 and 96.45%, respectively, in 30 min.

Effect of particle size

It is evident (Tables 1 and 2) that the amounts of metal ion adsorbed increased with a decrease in the particle size of pollen grains, explaining the increasing sorption rate at small dimensions. High adsorption by pollen grain with smaller particle sizes is due to the availability of more specific surface area on the adsorbent (Karthikeyan et al., 2004). Thus different particle sizes had different uptake capacities; DCPI>DCPII>DCPIII.

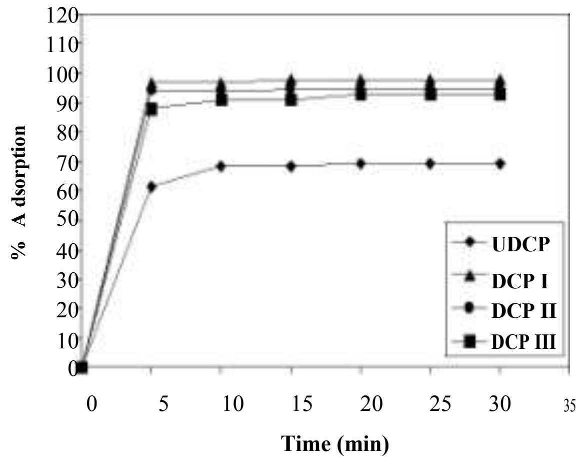

Figure 1. Effect of contact time on Cu (II) ion adsorption onto UDCP, DCP I, DCP II and DCPIII.

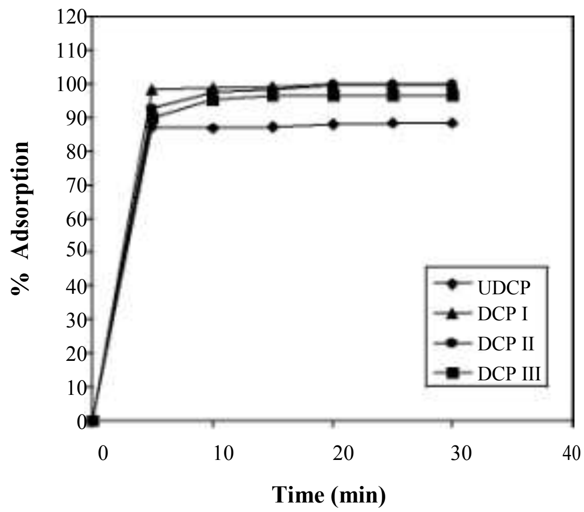

Figure 2. Effect of contact time on Zn (II) ion adsorbed onto UDCP, DCP I, DCP II and DCPIII.

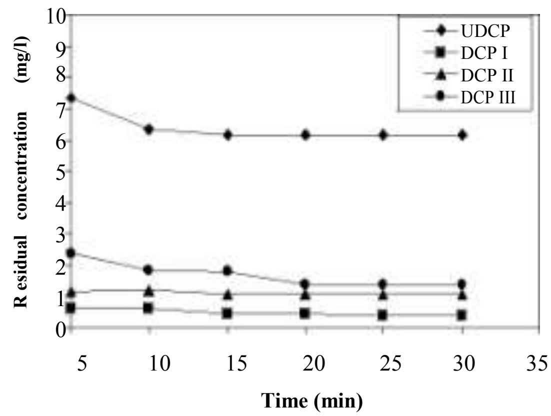

Figure 3. A plot of residual concentration of Cu (II) ions adsorbed onto UDCP, DCP I, DCP II and DCPIII.

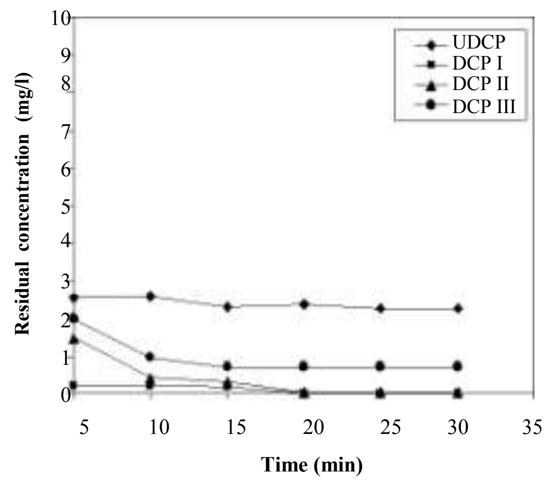

Figure 4. A plot of residual concentration of Zn (II) ion adsorbed onto UDCP, DCP I, DCP II and DCPIII.

Plots of the effect of contact time on adsorption of Cu(II) and Zn(II) onto undyed and dyed coconut pollens (Figures 1 and 2) show that the sorption curves exhibit initially a linear position followed by plateau region at longer time, which shows that adsorption has reached its peak in 15 min. Also, plots of residual concentrations against time (Figures 3 and 4) confirmed adsorption of the metal ions. The results show that copper and zinc ions bound to the adsorbents in less than 15 min. This can be explained in terms of dying with reactive dyes which modified coconut pollens by the introduction of sulphonic acid groups. Therefore, adsorption by the dyed coconut pollens depended on its properties such as the hydrophilicity of the sulphonic acid groups, high cross linking of the adsorbents structure and ease of displacement of the counter hydrogen ion. Therefore, removal of metal ions by dyed pollen grains could be due to two different sorption processses, a fast ion exchange followed by chemisorptions as suggested by Low et al. (1992) in their earlier work on dye-treated oil-palm fibres.

Effect of co-ions

The study of the influence of co-ions on the removal of Zn (II) ions becomes relevant when the selective adsorption of the metal ion occurs from the aqueous system. The experimental results revealed that the presence of Cu (II) ion diminished the adsorption of Zn (II) ions. This is attributed to the fact that the hydrated copper ions have smaller radii (0.071 nm) than hydrated zinc ions (0.074 nm) and thus have greater access to the surface of the adsorbent. Earlier studies have also reported a similar co-ionic effect in the removal of of specific metal ions in their studies using dye treated palm fibres (Low et al., 1992).

Conclusions

In the present study, it is observed that an optimum contact period of 10 min is required for the maximum removal of Zn (II) and Cu (II) on dyed coconut pollen. The adsorption mechanism also depends upon the particle size of the adsorbent. The fraction of adsorption increases with decrease in particle size.

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