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Study on the effectiveness of the peels of *Musa Sapientum* (MSP) and *Musa Cardaba* (MCP) for the removal of heavy metal (Fe and Cd) from wastewater

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ABSTRACT

The removal of heavy metals Cd(II) and Fe(II) from artificially contaminated water has been investigated with the aim of detoxifying industrial effluents before their safe disposal into land and river waters. The peels of musasapientum (MSP) and musacardaba (MCP) were used to remove Cd(II) and Fe(II) from synthetic waste-water. The effect of contact time, initial metal concentration, and the adsorbent dose on the adsorption efficiency of the adsorbents were studied. Batch mode experiments were carried out by agitating the adsorbents with the metal solution and then separating by filtration. The residual metallic concentration was determined using Atomic Absorption spectrophotometer AAS. The peak percentage sorption of both metal ions by the two adsorbent were above 99.5% and the equilibrium time was between 25-30 minutes. The high adsorption capacity of the two adsorbents forCd(II) and Fe (II) within a short time makes them potential alternative for the removal of these ions from waste- water.

Keywords: Adsorption, Waste water, *Musa Sapientum, Musa Cardaba,* Effectiveness, Cd(11), Fe(11),

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INTRODUCTION

One of the most critical problems of developing countries is improper management of vast amount of waste generated by various industrial activities. More challenging is the unsafe disposal of these wastes into the ambient environment. Waste- water produced in the various industries constitute potential hazards for our environment as they introduce various contaminants such as heavy metals into soil and water resources. At present heavy metals are the most important pollutants in surface and ground water, Brinzen et al (2009). These water bodies are often rendered unsuitable for both primary and secondary usage, Fakayode(2005). Metals exist in waste waters in many forms including soluble, insoluble, inorganic, metal- organic, reduced, oxidized, free metal, precipitated, adsorbed and complexedTashiro*et al*(1975). These heavy metals have toxic effect on many life forms and so must be removed from waste- waters before discharging them into the sewage system. Thus the safe and effective disposal of industrial wastewater is a challenge for industrialist; environmentalists and researchers.

The conventional way of treating or removal of heavy metals from waste- water includes precipitation, membrane filtration, ion exchange, adsorption and co-precipitation. These methods have found limited application because of their high capital and operational cost. Studies on the treatment of effluent bearing heavy metals have revealed adsorption to be highly effective for the removal of heavy metals from waste water but activated carbon, despite being very expensive, has been extensively used as an absorbent Chand *et al(* 1994). In recent time, new approaches based on the use of inexpensive and efficient alternatives in removing heavy metals from waste water have been reported, Badmus*et al(* 2007;). Agricultural waste such as sugar bagasse (Mohan *et al* 2002);

Rice husk (Munaf*et al.*, 1997): Saw dust (Selvi*et al.*, 2001):Coconut husk (Chand *et al.*, 1994); Neemhusk (Ayub*et al.*, 2001); Rice husks (Ajimal*et al.*, 2003); Saccharomyces Cerevision (Wang J.L *et al.*, 2006): Crop milling waste (Saeed A *et al.*, 2005) ,Used blanck Tea leaves (Hossain M.A et al 2005.)PolypogonMonspeliensis Waste (Ansari T.M et al 2009):.

In general an absorbent can be termed inexpensive if it requires little processing ,is abundant in nature or is a byproduct or waste materials from another industry (Nasim*et al.*, 2004). In Nigeria huge amount of agricultural waste are generated daily which cause environmental and disposal problems. Application of these wastes as adsorbent offers highly effective technological means for dealing with pollution of heavy metals and solving their disposal problems. There is therefore, an urgent need that all possible sources of agro-based inexpensive adsorbents should be explored and their feasibility for the removal of heavy metals should be studied.

This research contributes to the search for inexpensive adsorbent and their utilization possibilities in removing heavy metals from waste- water.

MATERIALS AND METHODS

The two species , Musa-sapientum and Musa cardaba were bought from Umuahia market in Abia State of Nigeria. Their peels were removed, washed, cut into small bits, air-dried for three days and then oven dried at 105℃ for 20 hours. Then the cripsy peels were pulverished separately using a clean mortar and pistol. The ground peels were sieved through a 0.25 mm sieve and stored in plastic container.

PREPARATION OF SYNTHETIC WASTE WATER

Stock solution 05.M of $Cd(II)$ and $Fe(II)$ ions were prepared indistilled and dionised water with cadmium chloride and ferrous sulphate respectively. All working solutions of varying concentrations were obtained by varying the stock solutions appropriately. All chemicals used were of analytical grade.

ADSORPTION EXPERIMENTS

Batch mode experiments were conducted by agitating the adsorbent with the metal solutions under various experimental conditions. The parameters studied were the effect of contact time, the effect of initial concentration of the metal ion and the effect of adsorbent dose on the sorption efficiency. The absorbent was then separated from the experimental system using whatman No 42 filter paper. The un-adsorbed metal ion concentration was analyzed spectrophotometrically using PYE, Unicom, SPG, Atomic Absorption spectrophotometer AAS. The experiments and analysis were carried out in duplicates.

RESULTS AND DISCUSSION

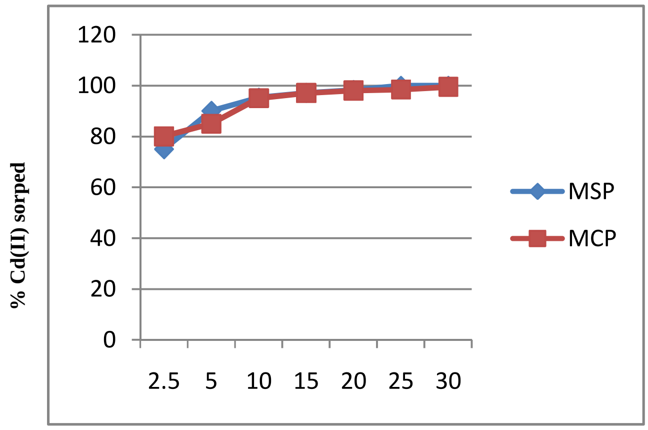
The results showing the adsorption capacity of the peels of musacadaba (MCP) and Musa Sapientum (MSP) on $Cd(II)$ and $Fe(II)$ ions are shown in tables 1-3.The corresponding plots of the different variables are illustrated in figures 1-3.

Table 1: Effect of contact timeon the sorption capacity of MSP AND MCP for the metal ions Cd(II) and Fe(II)

	Contact Time	**% of Cd^{2+}sorped by**		**% of Fe^{2+}sorped by**	
S/N	Minutes	(MSP)	(MCP)	(MSP)	(MCP)
1	2.5	75	80.02	65	62.5
2	5	90.01	81.25	79.8	78.8
3	10	95.2	95.00	95	93.5
4	15	97.1	97.00	96.8	96.7
5	20	98.2	82.2	97.5	97.8
6	25	99.86	98.95	98.30	98.00
7	30	99.89	99.50	99.45	99.00

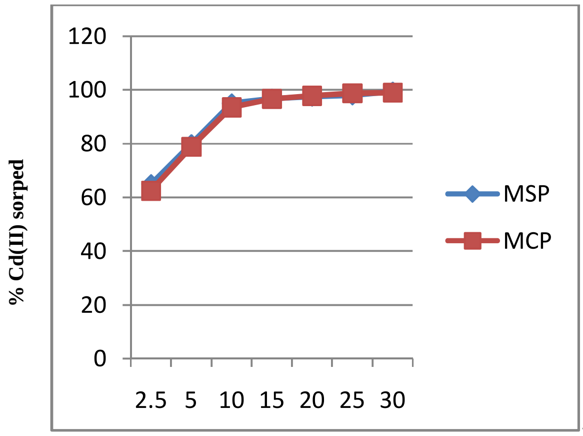
Wt of absorbent.1g: ; metal ion conc.10mg/L

Fig. 1(a) Effect of contact time on the sorption capacity of MSP & MCP for Cd(II)



wt of ad sorbent 0. 1g: conc. of metal 20ml of .01MCd(II)

Fig. 1(b) Effect of contact time on the sorption capacity of MSP & MCP for Fe(II)



wt of absorbent 1g: conc. of metal 20ml of .01M Fe(II)

EFFECTS OF CONTACT TIME

Table 1 and fig 1 (a & b) show the effect of contact time on the sorption capacity of (MSP) and (MCP) on $Cd(II)$ and $Fe(II)$ from solution. The percentage sorption of $Cd(II)$ and $Fe(II)$from solution increased steadily with time until after 25 minutes when it almost became constant at 30 minutes of contact. The percentage sorption was above 99% at 30 minutes for $Cd(II)$ and above 98% for $Fe(II)$ by both absorbents.

Table 2: Effect of metal ion concentration on the sorption capacity of (MSP) and (MCP) for the metal ions$Cd(II)$and $Fe(II)$

	Metal ion conc.	% of Cd^{2+} sorped by		% of Fe^{2+} sorped by	
S/N	ml of .01M	(MSP)	(MCP)	(MSP)	(MCP)
1	10	99.8	99.71	99.5	99.4
2	20	99.0	99.62	99.2	99.00
3	30	95.3	99.50	98.6	98.50
4	40	99.0	93.40	92.55	93.80
5	50	99.8	89.60	88.50	86.45

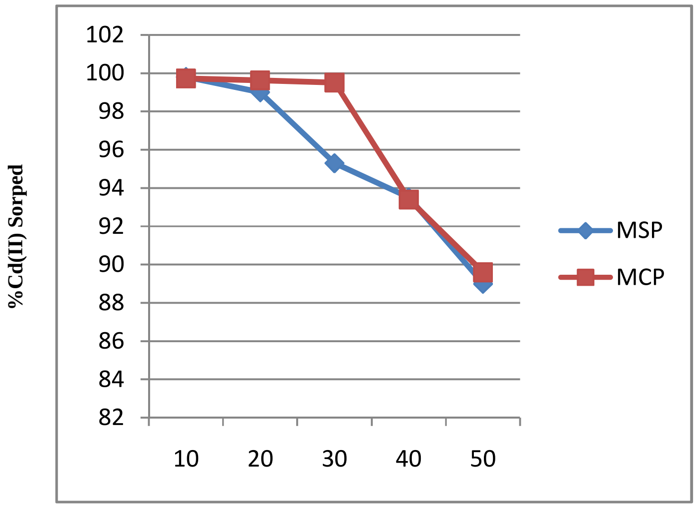
Wt of adsorbent 0.1g :Time 30 mins.

EFFECTS OF METAL ION CONCENTRATION

Tables 2 and fig.2 (a&b) are the results of the effect of $Cd(II)$ and $Fe(II)$ concentration on the sorption capacity of the adsorbents (MSP) and (MCP). The percentage adsorption of $Cd(II)$ and $Fe(II)$ from solution decreased with increase in the concentration of the metal ions. For $Cd(II)$, the sorption by (MSP) decreased from 99.8% capacity at 10mg//l $Cd(II)$ concentration to 88.6% at 50mg/l Cd(II) concentration while the percentage sortion by (MCP) decreased from 99.7% at 10mg/l Cd(II) to 89.5% at 50mg/l Cd(II) concentration.

For Fe(II) the sorption capacity of MSP decreased from 99.5% at 10mg/l metal concentration to 88.5% at 50mg/l Fe(II) concentration while the sorption by MCP decreased from 99.45% at 10mg/l $Fe(II)$ concentration to 86.45 at 50mg/l concentration This decrease in the percentage sorption is due to the increase in the number of ions competing from the available binding sites on the surface of the adsorbents. This is alsocomplemented by lack of sufficient active sites on the adsorbent for interaction with the metal ions at high metal concentrations resulting in more metal ions being left un-adsorbed in solution. This agrees with the work of Krishau et al.,(2003), Kafia et al.,(2011) and Abii,(2012)

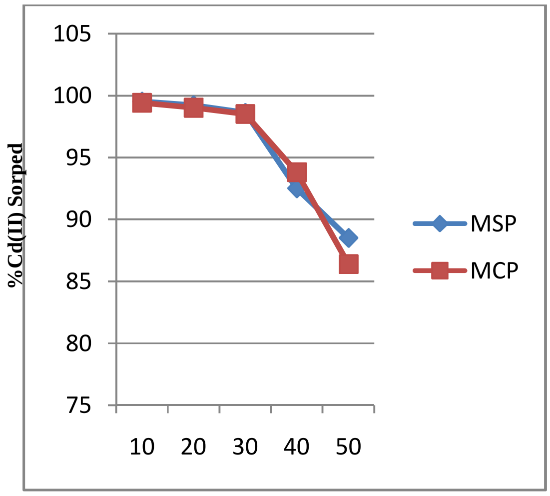
Fig. 2(a) Effect of metal ion concentration on the sorption capacity of (MSP)&(MCP) for Cd(II)



Mg/L

[wt of adsorbent 0.1g. Time 30 mins]

Fig. 2(b) Effect of metal ion concentration on the sorption capacity of(MSP)&(MCP) for Fe(II)



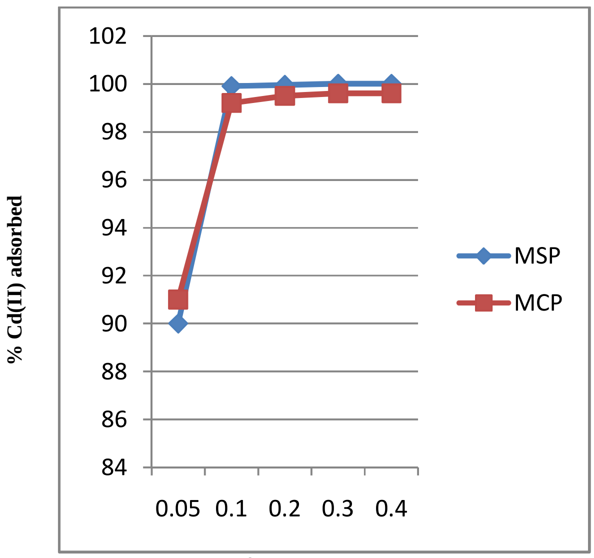
Mg/L

[wt of adsorbent 0.1g. Time 30 mins]

Table 3: Effect of absorbent wt on the sorption capacity of (MSP) and (MCP) for $Cd(11)$ and Fe(11)Time30mins

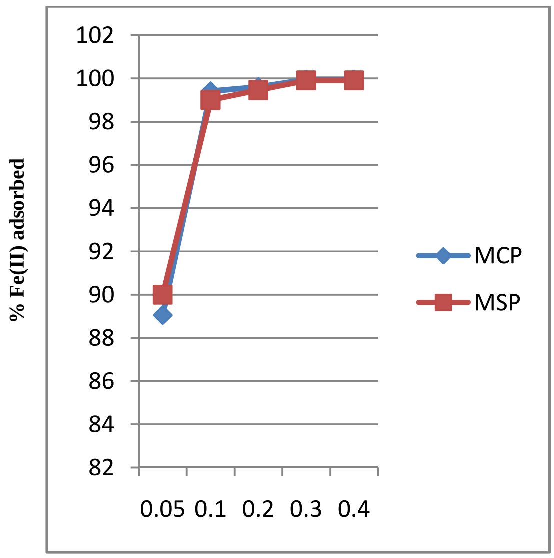
	Wt of adsorbent	% of Cd^{2+} sorped by		% of Fe^{2+} sorped by	
S/N	(g)	(MSP)	(MCP)	(MSP)	(MCP)
1	.05	90.00	91.00	89.05	90.00
2	.1	99.90	99.20	99.40	99.00
3	.2	99.95	99.50	99.60	99.40
4	.3	100	99.60	99.95	99.95
5	.4	100	99.60	99.95	99.95

Fig. 3(a) Effect of adsorbent dosage of the MSP & MCP on their adsorption capacity for Cd(II)



wt of adsorbent (g)

Fig. 3(b) Effect of adsorbent dosage of the MSP & MCP on their adsorption capacity for Fe(II)



wt of adsorbent (g)

Effect of Absorbent Dose on Their Sorption Capacity for Cd(11 and Fe(11)

Table 3 and fig. 3 (a and b) show the effect of adsorbent dose on their capacity to adsorb Cd(11) and Fe(11) This was achieved by varying the adsorbent dose from 0.05g to 0.5g in a 20ml of 0.01m and of metal ion for a period of 30minutes. There was increase in the sorption capacity of both adsorbents as their sizes increased. The increase in size gives rise to increase in the number of binding sites available for the metal ions which results to increase in adsorption (Goug*et al.*, 2005)

CONCLUSION

The experimental results show that the peels of *Musa Cardaba* (MCP) and *Musa Sapientum* (MSP) are very effective for the removal of $Cd(II)$ and $Fe(II)$ from contaminated aqueous solution. The rapid uptake within 30minutes and high capacity of the two biomass (MSP) and (MCP) for $Fe(11)$ and $Cd(11)$ sorption are noteworthy. Considering that equilibrium time is one of the most importanteconomic parametersthat is considered in waste- water treatment system, the two biomas(MSP)and(MCP) can be considered as excellent alternative to the expensive carbon for the removal of $Cd(II) and Fe(11) from\ solution.$

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