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Sorption Modles Of Lead(II) Ions Onto Agricultural Tuber Waste Bio Mass

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ABSTRACT

The sorption capacities of tuber agricultural wastes for the removal of lead(II) ion from aqueous solution were studied. The data obtained therefore were modeled using two physical chemistry isotherm models; Langmuir and Dubinin-Radushkevich models respectively. The results of these modeling showed that each of these tuber waste biomass fitted into these established models. The Qmax obtained from the modeling was thus; Qmax for yam peels>Qmax for cassava peels>Qmax for sweet potato peels. The sorption energy obtains showed a reverse trend:- sweet potato peels>cassava peels>yam peels. The obtained langmuir constants for these tuber waste biomass are closely related in values.

KEYWORDS

Lead(II);
Sorption models;
Tuber waste biomass;
Biosorbent.

INTRODUCTION

Lead in one of the oldest metals known to man at discovery, mining, and uses dated over seven thousand years,[1,2]. Lead is one of the metals that has no chemical, biological and bio chemical benefits to man[3,4]. Lead, cadmium and mercury are examples f metals that have been grouped as priority pollutants by the U.S. Environmental protection agency[5,6]. Among in organic contaminants in the environments; solid, lend and aquatic; lead and cadmium are of public health interest due to their high toxicity after bi accumulation in multiple organs in the human body[7,8]. Lead has been found to bio accumulate in food, soil has been found to bio accumulate in food, soil, and street dust to anthropogenic activities[1,9]. Lead when in fasted by man, inhale or consumed through contaminated food can cause genetic mutation, cancer, metal recordation, ion children, colic anemia, and venal diseases among other toxic effects[1,6,8,9]. There is, therefore the need to remove, lead from the aqueous environment even when' it is present at trace level. The conventional methods of lead removal from aqueous solution especial wastewaters is costly, not readily available and in some cases introduces novel chemicals to the environment[6,10]. There comes the need to develop an alternative cost effect, and environmentally friendly method which is the subject of the present paper and the associated modeling carried out. The two isotherm models examined in this report include:-

The langmuir model. This model is used to estimate the maximum sorption capacities of these tuber waste biomass corresponding to complete monolayer waste biomass corresponding to complete monolayer coverage of lead(II) onto these biobsorbent surfaces.

This is expressed by:

$$Qe = \frac{Q_{max}KlCe}{1 + KlCe}\frac{(i)}{(ii)} \quad (1)$$

where Kl(Lg-1) is a constant which relates the sorption energy, Qmax is the maximum sorption upon complete saturation of these tuber waste biomass surface, Ce is he initial concentration of the lead(II) in the aqueous solution, Qe is the amount of head(II) sorbed by each of these tuber waste biomass at specified contact time(t)(6,II).

A Linear form of the equation I above after rearrangement is given by

$$Ce/Qe = \frac{I}{Q_{max}} \quad Kl = \frac{Ce}{Q_{max}} \quad (2)$$

The experiment data obtained from each of these three tuber waste biomass were fitted into equation 2,by plotting Ce/Qe values against the value of Ce.

The slope of this plot yield the reciprocal value for Q_{max} and the intercept of each of these plots yield he langamuir constant(Kl).

Dubinin-Radshkelvich model: This model is used to estimate the characteristic porosity of each of these tuber waste biomass investigated for lead(II) sorption and the apparent energy of sorption.

This model is represented as:

$$Qe = QD \exp(BD\, RTln(1 + 1/Ce)^2 \quad (3)$$

where Qe is the amount of lead(II) sorbed by each of these tuber waste biomas studied, QD is the Dubinin-Radushlkevich constant that relates the degree of sorption by each of these biomass, BD is related to the energy of sorption per move of lead(II) ion as it moves from infinite distance in the aqueous solution, and Ce is the initial conception, of the lead(II) in the aqueous solution.

A Linear form of equation is given by:

$$In\, Qe = In\, QD - 2BD\, RT\, In(1+1/Ce) \quad (4)$$

The experimental data obtained from sorption studies of lead(ii) ion onto each of these tuber waste biomass were fitted into equation 4 by plotting in Qe against RT In(4i/Ce). The slope of this plot yield the value of -2 BD which is the apparent energy of sorption for each of these tuber waste biomass studied The energy of the sorption can be calculated thus;[6,11,12].

$$E = \frac{1}{\sqrt{2BD}} \quad (5)$$

In this study the sorption models of lead(II) ion in aqueous solution is reported using tuber waste biomass as biosorbent materials.

MATERIALS AND METHODS

Sample collection

White yam tubes(Dioscera rotundata) cassava tubes (manihot esculanta) and sweet potato tubes(Ipomea batata) were procured from the root crop research institute farm, located in Umudike, Abia State, Nigeria. These three tuber crops were identified and authenticated by Osuegwu C,U, of taxonomy unit, department of botany, Micheal Okpara University of Agriculture, Umudike,Abia State, Nigeria. All chemical reagents are analytical grades from BDH Chemicals Ltd., London.

Sample preparation

These tuber crops procure were washed clean, with distilled-deionised water, and each peeled manually with domestic knife. Each of the tuber peels were collected differentely into a clean labeled stainless steel trays. The content of each they was air-dried for 7days. The each of the peels was oven dried at 65^0C for 24hr. Each dried sample was ground into powder using an electric milling machine(binatone model). Each of these milled samples was sieved into 2mm-particle sizes using a 2mm-steel sieve. Each fine powder thus obtains was stored in a labeled plastic reagent bottle until it is required for the sorption studies.

Preparation of lead(II) solution

Lead acetate equivalent to 38gram of lead(II) ion was weighed out and taken into a one-litre volumetric flask, 25Mlof distilled-deionised water was measured out and was added, shaken vigorously to achieve complete dissolution. The one litre volumetric flask was made up to mark with deionised water to obtain one molar lead(II) solution. Sorption student; To study the effect of concentration of lead(II) on the sorption behavior of the three tuber waste biomass:- a serial dilutions of the heal(II) solution were prepared.

The serial dilutions were O.1M, O.2M, O.4M, and O.6M, equivalent to3.80g/L, 7.60g/l,15.20g/L and 22.80g/L of lead(II),. Respectively. Four conical flasks each labeled with an appropriate concentration of lead(ii) ion were set up. Ten milliliter(10ml) of each concentration was measured out and taken into the appropriately labeled flask, O.1gram(100mg) each of Dioscerea rotun data) peels, (manihot esculenta) peels and(ipomea batata) peels was measured out and added into each of four labeled flask, stirred and allowed contact time of twenty-five minutes each.

At the end of the 25 minutes intervals, each of the flasks was filtered using No. 40 what man filter paper aided by suction pump.

Each filtrate was stored in a clean labeled regent bottle for A.A.S analysis.

The above sorption study procedures were exactly repeated using varying concentrations of lead(II) ion solution and different tuber waste biomass. Atomic Absoption spectrophotometric Analysis: Each of the sample filtrates was analyzed at 283 nm wavelength for lead(II) using Unicam 916 model.

RESULTS AND DISCUSSION

The results of the modeled equations and the resulting plots obtained from each model are showed in figures 1, 2 and 3 respectively. The data used in each plot was presented in TABLE 1. From figure 1, it was showed that increase in initial incantation of lead(II) solution depicted an increase in sorption of each of the tuberous waste biomass studied. At the contact time of twenty five minutes interval at which the sorption activity was monitored, each of these tuber waste biomass has not attained equilibrium saturation position. This is depicted by a straight line nature of the concentration plot. Figure 2, the langumuir plot do not yield a straight line plot but a reciprocal plot. This model was effectively used in obtaining the maximum sorption capacity of each of these tuber waste biomass modeled as presented in TABLE 2. From TABLE 2, the langmuir model showed yam peels with maximum sorption capacity of 332. 33l/g followed by cassava peels 227. 273L/g. The least in term of maximum sorption capacity been sweet potato peels. These values correlates positively with percent sorption of lead(II) ion by each of these tuber-

TABLE 1 : Data obtained for lead(II) ion sorption onto tuber agricultural wastes

Biomas	Ce(g/l)	Qe(g/l)	Ce/Qe	In Qe	RT In(1+i/Ce)	% sorption
Yam peels	3. 80	3. 549	1. 071	2. 267	48. 557	93. 40
"	7. 60	7. 385	1. 029	2. 00	25. 693	97. 20
"	15. 20	14. 969	1. 015	2. 706	13. 243	98. 48
"	22. 80	22. 546	1. 011	3. 116	8. 922	98.89
Cassava peels	3. 80	3. 347	1. 013	1. 266	48. 557	93. 34
"	7. 60	7.359	1.038	1.996	25. 693	96. 83
"	15. 20	14. 949	1. 0168	2. 705	13. 243	98. 35
"	22. 80	22. 535	1. 0118	3. 115	8. 922	98. 84
Sweet potato peels	3. 80	7. 612	1. 0434	1. 293	48. 557	95. 84
"	7. 60	7. 355	1. 0333	1.995	25. 693	96. 78
"	15. 29	14. 787	1. 028	2. 694	13. 249	97. 28
"	22. 80	22. 552	1. 011	3. 116	8. 922	98.71

TABLE 2 : Equilibrium constants for sorption models of lead (ii) ion onto tuber agricultural wasted

Biomass	Langmuir Model		Dubinin-radushkevich	Model	
	Q_{max} (L/g)	KL (L/g)	QD (g/L)	-BD calories/mole	E (calories)
Yam peels	33. 33	1. 018	6. 172	5. 807	0. 294
Cassava peels	227. 273	1. 021	67. 357	4. 165	0. 346
Sweet potato peels	33. 33	1. 014	33. 116	1. 200	0.646

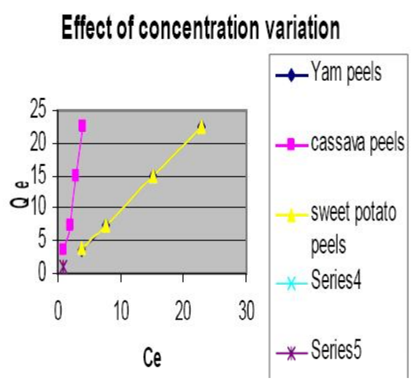

Figure 1: The concentration plot

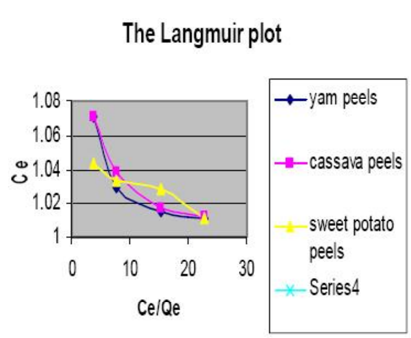

Figure 2 : The langmuir plot

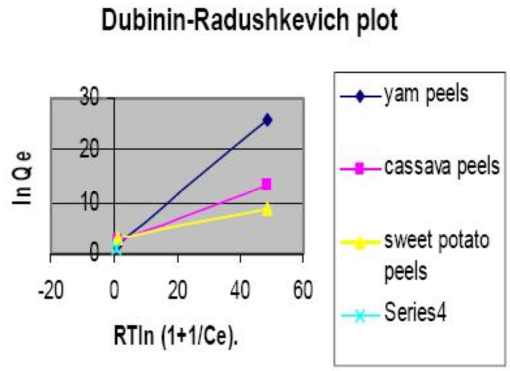

Figure 3 : Dubinin-Redushkevich plot

ous waste biomass(TABLE 1). Figure 3, showed the plot obtains using Dubinin -Radushkevich model. The straight line nature of this plot showed a good model of tubes waste biomass for lead(II) ion solution. This model was used to predict and calculated the free energy f lead(II) ion sorption by each of these tuber waster biomass as shored in TABLE 2.The negative values of the parameter-BD suggests that the sorption of lead(II) ion by tuber waste biomass is exothermic in nature. This may explain why the sorption is rapid, fast and sorption present level of up to ninety-eight percent obtained for yam peels and cassava peels within the contact time interval of twenty-five minutes. The sorption free energy of the lead(II) ion using there tuber waste biomass showed that sweet potato peels requires more energy for maximum sorption capacity attainment and so yielded the least maximum sorption capacity(TABLE 2.)

The over all results have showed that these standard isotherm models langmuir model and Dubinin-Radushkevich model can be used in the prediction of Maximum sorption capacities of tuber waste biomass, sorption porosity and face energy of sorption for lead (II) ion from aqueous solution.

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