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Evaluation of *Dacryodes edulis* (native pear) seed biomass for Pb (II) sorption from aqueous solution

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ABSTRACT: Dacryodes edulis (Native pear) seed is herein evaluated as a promising biomass for Pb(II) removal from aqueous solution. The Pb(II) adsorption onto Dacryodes edulis seed biomass was influenced by the solution pH, time, biomass dose and initial adsorbate concentration. The Freundlich model fitted better than the Langmuir model which also gave a good fit when the experimental data were represented on both isotherm models. The kinetic data clearly established the pseudo – second order model as a more appropriate model for describing the Pb(II) ion sorption onto pulverized seed of Dacryodes edulis. This investigation shows that at pH 5, biomass concentration, 50 mg/L; temperature 28 ^{o}C and contact time 90 minutes, a Langmuir monolayer adsorption capacity of 10.42 mg/g was obtained. This is an indication that the native peer seed is an efficient biosorbent for Pb(II) ions removal from aqueous environment. © JASEM

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***Keywords*:** Dacryodes edulis, kinetics, isotherms, uptake and adsorption efficiency.

Heavy metals in the environment have been on the increase arising from man's industrial activities and technological advancement. All processes involving metals in their productive cycle generate effluents containing significant heavy metal ions (Anushree, 2004). Mine drainage, land fill leachate, leather industries, refining, electroplating, domestic effluents, dye industries and agricultural runoffs all generate waste waters which contain some reasonable amount of these heavy metal ions (Aksu and Kutsal, 1991).
Some heavy metals are needed for the plant growth but above a certain level or amount, they become toxic. Certain metal ions inhibit various enzymes which mineralise organic compounds in the soil (Uslu and Turklamen, 1987). Human exposure to most heavy metals even at low concentrations can lead to serious malfunction in the reproductive, renal and central nervous systems (Manaham, 2004). To reduce the associated dangers of exposure, their concentrations in effluents must be reduced to standard acceptable levels before they are discharged into the environment.

The metals of topmost concern are lead, chromium, copper, zinc, iron and cadmium (WHO, 1984). Since lead is generally used in a lot of applications, there are many potential sources of its introduction into the environment. Lead is used in industries as raw material in the manufacturing of storage batteries, pigment, leached glass, fuels, photographic materials, solder and steel product (Gupta & Rastogi, 2007). Lead is highly toxic even in very low concentrations. Severe lead poisoning can cause encephalopathy with permanent damage, damage to the kidneys, the nervous system, the reproductive system, the liver and the brain (Ozer, 2007) while moderate lead poisoning result in neurobehavioral and intelligence deficit syndrome (Chen *et al*., 2007).
According to the United States Environmental Protection Agency (USEPA, 1986) the tolerance

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values for lead II in waste water and potable water are 0.1 mg/L and 0.015 mg/L, respectively.

As a result of the harmful effect of this contaminant on environment, there has been serious interest in the removal of this metal from contaminated soil and waste water. Scientists have developed a number of technologies used in the removal of toxic metals from water. The most important of these are: chemical precipitations, elcetrofluoration, ion – exchange, reverse osmosis and adsorption onto activated carbon (Gaikward, 2004). The demerits of these methods include their being expensive and ineffective when metals are present in solution at very low concentrations (Baig *et al*., 1999). On the other hand, when the concentration of these heavy metal ions is high in the effluent (say 1 – 100 mg of heavy metal ions per liter), the consequence includes requirement of high energy and more reagent, incomplete removal of the contaminating metal ions and secondary pollution problems through the generation of sludge or other toxic waste products (Volesky, 1990). These demerits have prompted the use of agricultural by-products as adsorbents for the removal of heavy metals from aqueous solutions in a process referred to as biosorption.

The biosorption method involves the use of agricultural wastes that are available at low cost. Parts of plants of natural abundance and animal waste or by – products are capable of removing substantial amounts of metals ions from aqueous solutions usually through chelation or ion exchange mechanism (Abia *et al*., 2003; Gardea, *et al*., 1999; Igwe *et al*., 2005). To enable the process, the presence of functional groups such as carboxylic, phenolic, hydroxylic, cyano groups and so on are needed as active adsorption sites for attraction, binding and consequent seperation of the metal ions from target solutions (Abia *et al*., 2003). Biosorption has some merits over the conventional methods which are: low operating cost, reusability of biomaterials, selectivity for specific metals, short operation time and no chemical sludge. It is also environmentally friendly (Mungasavalli, *et al*., 2007).

According to literature, the biosorption process involves two phases (Somorjai, 1993). The solid phase is the adsorbent while the adsorbate solution containing dissolved species to be adsorbed, is the liquid phase. The adsorbent and adsorbate species attract to each other and bind by any of the different mechanisms such as ion exchange, chelation and so on. The adsorption process continues till equilibrium is attained between the amount of adsorbed heavy metal ions on the adsorbent and the amount of metal ions left in the solution or liquid phase. The extent to which the adsorbate species is distributed between both phases depends on the affinity of the adsorbent for the adsorbate species (Volesky and Holan, 1995).

The adsorbent material is usually a waste product that is abundant in nature and useless in other areas, other than in this application. Many biosorbent materials of agricultural base have been tested and found applicable for heavy metal biosorption. These include Coconut husk and shell, sea weeds (Senthikumar, *et al*., 2007) and a lot more. Rafaqat & Moonis, (2002) reported the efficacy of Neem oil cake, a biowaste material, for Cu^{2+} and Cd^{2+} uptake from aqueous solution. Ofomaja and Ho, (2007) reported the use of Mansonia wood sawdust in adsorbing methyl violet dye. Eguvbe, (2007) and Egurefa, (2008) reported the use of Yam peelings and fallen dried almond leaves (*Terminalia Catappa L.*) respectively as effective biosorbents for heavy metal uptake from aqueous solutions. A series of other agricultural tuber wastes have also been investigated (Okoro & Okoro, 2008). These again have added to the sorption bank. Apart from agricultural wastes, many plant materials of natural abundance have also been reported as potential biosorbents for heavy metal uptake. Sekhar *et al.,* (2002) reported the use of bark of *Indian sarsaparilla* for the removal of Pb^{2+}, Cr^{3+} and Zn^{2+} ions from aqueous solutions. Okuo & Oviawe, (2007) reported the use of cassava fibre modified with citric acid as good biosorbent for selective sorption of mixed heavy metal ions. Also Baig *et al.,* (1999) reported the use of silverleaf nightshade as potential biosorbent for sorption of heavy metal ions from aqueous solution. Horsefall & Spiff, (2004) reported the use of stems of fluted pumpkin (*Telfaria occidentalis Hook F.*) as biosorbent for sorption of Co^{2+}, Al^{3+} and Ag^{+} from aqueous solutions. Prasad & Freitas (2000) studied the use of leaf, stem and root of phytomass of *Quercus ilex L* (holly oak) in removing heavy metals from aqueous solutions. From their studies, the roots had the greatest potential for heavy metal adsorption followed by the leaf and then the stem. Also, Pandey *et al.,* (2007), investigated the potential of the plant *Calotropis procera* for heavy metal uptake from aqueous solutions. In their study, the root bark of the plant was used and both leached and unleached biomass was prepared and successfully used for Ni^{2+} removal from synthetic and real industrial effluents and the technique appeared viable and industrially feasible. The leaf biomass of *Calotropis procera* was also evaluated and reported by Overah (2011) and Babalola *et al*. (2011) as good adsorbent for the adsorption of Cr(III) and Cd(II) respectively from aqueous solutions. The aim of this work therefore, is to add to the sorption bank by evaluating the seed biomass of *Dacryodes edulis* (African native pear) for its potential for Pb(II) ion sorption from solution through a batch study under different conditions of pH, contact time, adsorbent dose and adsorbate concentration and by modeling of the experiment data to assess its feasibility and applicability in terms of kinetics and equilibrium study.

Moreover, the native pear seed waste constitutes a great environmental nuisance in its season. Therefore, employing it in biosorption of Pb (II) ions from aqueous solution will make it useful and sort for, thereby reducing the level of nuisance it constitutes to the environment. To the best of the author’s knowledge, there is no record of the use of the seed biomass of *Dacryodes edulis* for adsorption studies.

MATERIALS AND METHOD

The following materials were used in this work: a Jenway 3510 model pH meter (for measurement of pH) whose combined glass electrode was calibrated each time with pH 4 and pH 7 buffer solutions, a Buck Scientific Flame Atomic Absorption spectrometer (FAAS) model 2004 (Germany) (for residual metal ion analysis),

Mettler AE 200 analytical balance, a thermostated water-bath/mechanical shaker, whatman no.1 filter paper, pipette filler, bulb pipette, beakers and conical flasks. The reagents used include anhydrous lead (II) nitrate salt, concentrated and dilute solutions of hydrochloric acid and sodium hydroxide. The reagents were all of Analytical grades and used without further purification. Origin 6.0, Hyperquad simulation and speciation statistical softwares and Microsoft excel 2003 were used to make the plots.

Sample collection and preparation of biomass: Native pear (Dacroydes edulis) seeds were collected from a trader in Ogwashi-ukwu fruit market in Aniocha North Local Government area in Delta State. These seeds were thoroughly washed with water to remove physical contaminants like sand then sun dried for six days, the epicarp of the native pear seed was removed leaving behind the seed endocarp which was pounded using a new mortar and pestle after rewashing and drying. To get finer particles, the pounded biomass was further pulverized using a new electric blender to prevent contamination. The biomass was then sieved with a 150 µm mesh screen, washed with dilute HCl acid, decanted and washed severally with de-ionized water till a neutral pH was attained. The neutral biomass was filtered and oven dried at 100 ^oC in an electric oven and stored in an air-tight poly-ethylene bag to prevent the biomass particles from adsorbing some water molecules.

Preparation of stock solution of Pb: The amount of Pb(II) in $Pb(NO_3)_2$ was determined stoichiometrically and dissolved in a 1000 cm^3 standard volumetric flask. The actual concentration of the Pb(II) in the prepared stock solution was determined by Atomic Absorption Spectroscopy and was used to carry out calculations for the serial dilutions.

Batch adsorption experiments: To study the effect of pH on the adsorption of Pb(II) onto *Dacryodes edulis* seed biomass, 50 mg of the biomass was weighed into appropriately labeled sample cups. 25 ml aliquots of the 100 mg/L Pb(II) solution at varied pH values were transferred into the sample cups. The pH ranged from 2 to pH 7. The pH of the various solutions was adjusted using 0.1M and 1.0 M HNO_3 and 0.1M and 1.0 M NaOH solutions. The weighed biosorbents were then contacted with the adsorbate solution in duplicates and agitated for an hour in the thermostated water bath/mechanical shaker. The suspensions were filtered using whatman no.1 filter paper and analyzed for residual metal ions by Atomic Absorption Spectroscopy.

To determine the effect of time, initial concentration of adsorbate solution and biosorbent dose, the same procedure described above was repeated but in each case, the parameter under study was varied while keeping the other parameters constant. Again, each of the experiments was carried out in duplicates (Pandey *et al*., 2007; Overah 2011; Babalola *et al*., 2011). Then the solutions were filtered and the filtrates were taken for AAS analysis to determine the residual metal ion concentration. Each experiment was duplicated.

The Pb(II) content in all the experiments of this study was determined by atomic adsorption spectrometer which was calibrated before use after system warm-up using spectroscopy grade standards. The instrument was checked periodically from the beginning to the end of the analysis for instrument response in order to maintain quality assurance.

Metal ion analysis: The amount of Pb (II) ions adsorbed per unit mass of the biosorbent during this study was determined using equation (1) while the bisorption efficiency was calculated using equation (2):

$$q_e = \frac{v}{m}(C_o - C_e) \qquad (1)$$

$$Biosorption\ efficiency = \frac{C_o - C_e}{C_o} \times 100 \qquad (2)$$

where q_e is the metal ion amount taken up by one gram of the *Dacryodes edulis* biomass (mg/g) at equilibrium, V is the volume of the adsorbate solution in contact with the *Dacryodes edulis* (L) m is the mass of the *Dacryodes edulis* used (g), C_e is the metal ion concentration remaining in solution at equilibrium and C_o is initial metal ion concentration in the solution (mg/L).

Data analysis: The kinetics of the adsorption of Pb(II) onto *Dacryodes edulis* was studied by fitting the data obtained from the time dependent study into the Pseudo first-order and Pseudo second-order kinetic models whose linear forms are represented by equations (3) and (4) respectively:

$$\log (q_e - q_t) = \log q_e - k_1 t/2.303 \qquad (3)$$

$$t/qt = 1/k_2 qe^2 + t/q_e \qquad (4)$$

where q_e and q_t are the amount of metal ions adsorbed at equilibrium and at time, t respectively, k_1 and k_2 are the Pseudo first-order and Pseudo second-order rate constants respectively.

The Langmuir and Freundlich adsorption isotherms were used to describe biosorption equilibrium in this study. This was done by fitting the data obtained from the adsorbate concentration study into the Freundlich and Langmuir adsorption isotherms represented by the linear equations (5) and (6) respectively.

$$\log q_e = \log k_f + 1/n \log C_e \qquad (5)$$

Where n and K_f represent adsorption intensity and adsorption capacity respectively and can be obtained from slope and intercept of the plot of log qe against log Ce.

$$1/q_e = 1/K_L q_m + 1/q_m\, C_e \qquad (6)$$

Where q_m is the Langmuir monolayer adsorption capacity K_L is Langmuir constant related to the affinity of binding sites for the metal ions and C_e is the aqueous concentration of metal ions at equilibrium. A plot of $1/q_e$ vs $1/C_e$ gives a straight line with K_L and q_m obtainable from the intercept and slope of the plot respectively.

RESULTS AND DISCUSSION

The effect of pH: It has been proven that pH is the most important parameter in biosorption of heavy metals because the chemical nature of the active sites of the biomass, and the form of metal species in solution are influenced by the pH of the solution (Al-duri, 1996). The Pb(II) ions uptake by the seed biomass of *Dacryodes edulis* at various pH values of 2-7 at 28 ^{O}C is shown in Figure 1. The uptake and biosorption efficiency of Pb(II) by the biomass was found to increase very slightly with an increase in the alkalinity of the adsorbate to pH 6 and later decreased slightly at pH 7. Therefore, pH 6 could have been said to be the optimum pH for lead ion biosorption by the seed biomass of *Dacryodes edulis*. However, at pH 6, some insoluble lead species exist as shown by the speciation diagram (Figure 2) generated for lead under the prevailing experimental conditions using the HySS (Hyperquad Simulation and Speciation) software which has been described by Alderighi *et al*., (2005). Therefore pH 5 was taken as the optimum pH for Pb(II) biosorption by the *Dacryodes edulis* biomass because at pH 5, virtually only the free Pb(II) ions exist and there was almost no precipitation of the Pb(II) ions at this pH. This result corresponds with the one reported on the effect of pH on biosorption of lead onto sugarcane bagasse and the composite of sugar cane bagasse/muti-walled carbon nanotubes (Hamza *et al*., 2013). Also, Sarada *et al*., 2013 reported an optimum pH of 5 for lead (II) adsorption onto *Araucaria heterophylla* leaf biomass. Castañeda *et al*., (2012) reported an optimum pH of 5.5 for Pb(II) adsorption onto snail shells. Qaiser *et al*., 2009 also reported an optimum Pb(II) biosorption onto groundnut hull at pH 5.

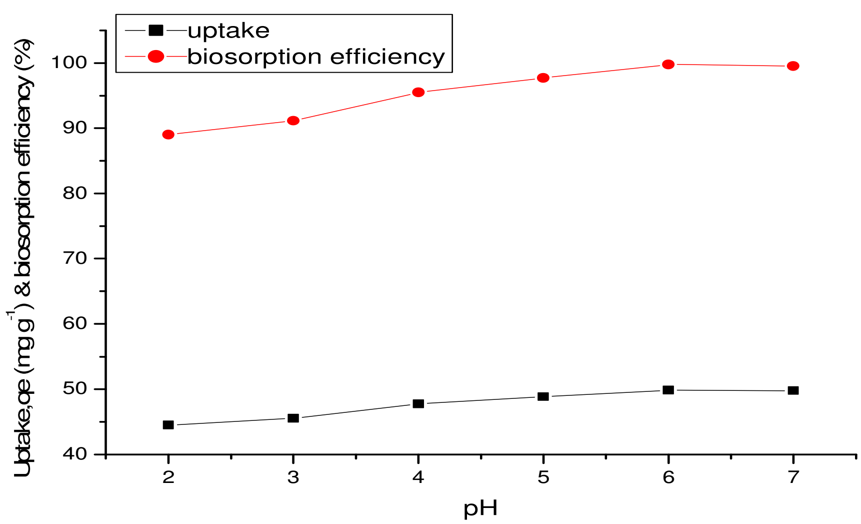

Fig. 1: Uptake and biosorption efficiency of Pb(II) as a function of pH, onto *Dacryodes edulis* [Conditions : 25 cm^3 of approximately 100 mg dm^{-3} Pb^{2+}, 50 mg of each adsorbent equilibration time - 1 hour, agitation speed - 150 rpm, temperature - 28 °C].

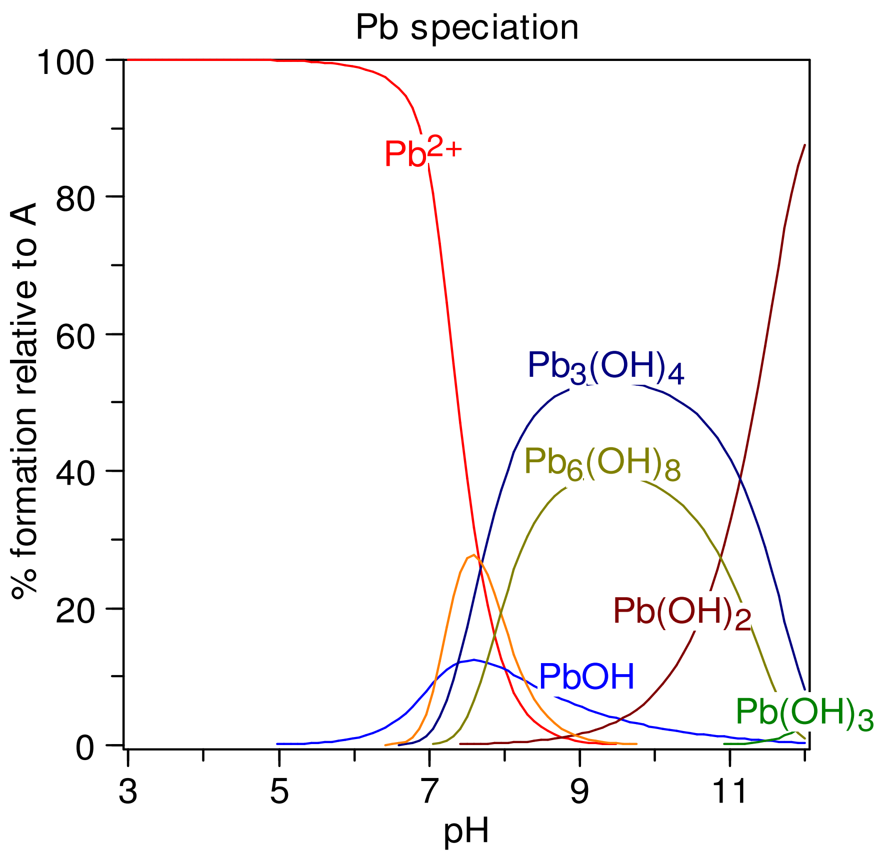

Fig. 2: Pb(II) Speciation as a function of pH [log β of $Pb(OH)^+$, 8.0; $Pb(OH)_2$, 17.54; $Pb(OH)_3^-$, 31.01; $Pb_3(OH)_4^{2+}$, 23.38; $Pb_4(OH)_4^{4+}$, 19.58; $Pb_6(OH)_8^{4+}$, 43.12; pKw 13.77, Ionic strength of about 0.1 mol dm^{-3}, Pb^{2+} concentration is 4.826 X 10^{-4} mol dm^{-3} at 28 °C].

*The effect of time***:** The time dependent experiment was carried out in order to determine the rapidity and kinetics of the process at the optimum pH of 5. The plot of the effect of time on Pb(II) uptake by *Dacryodes edulis* is shown in Figure 3.

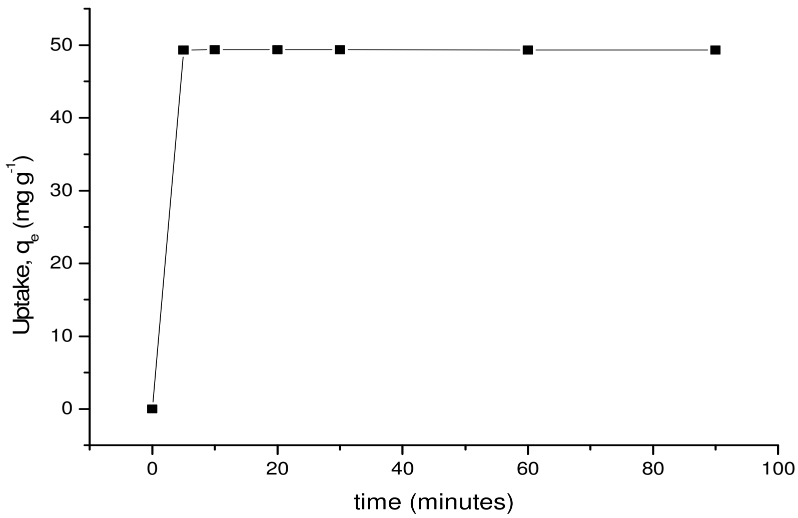

Fig. 3.: The effect of contact time on Pb(II) uptake onto *Dacryodes edulis* seed biomass [Conditions : 25 cm^3 of approximately 100 mg dm^{-3} Pb^{2+}, 50 mg of each adsorbent, pH - 5, agitation speed - 150 rpm, temperature - 28 °C].

The result indicates that the Pb (II) sorption unto *Dacryodes edulis* is a rapid process reaching a maximum only within 5 minutes after which there was a decrease in the uptake. This may be due to some second layer attachment of the ions to the biosorbent which with time desorb easily with continued agitation due to the weakness of the second layer attachment. Therefore, five minutes was used as optimum contact time in the following studies. According to Onyancha *et al*., (2008), the initial rapid phase within the first few minutes may be characteristic of a physical adsorption process or ion exchange at cell surface while the subsequent phase may be suggestive of other mechanisms like complexation, micro-precipitationand so on. In a number of reports, metal binding onto biosorbents is a rapid process. To mention a few, Overah (2011) and Babalola *et al*., (2011) reported just 10 minutes and 30 minutes for Cr(III) and Cd(II) binding respectively, onto *Calotropis procera* leaf biomass; Hamza *et al*. (2013), reported maximum Pb(II) binding at 2 hours and Castaneda *et al*. (2012) observed 80 minutes for maximum Pb(II) uptake by fresh water snail shells.

The effect of initial metal ion concentration: The experimental results of the biosorption of Pb(II) ions by the biomass of the pulverized seed of *Dacryodes edulis* at various initial metal ions concentration are shown in Figure 4.

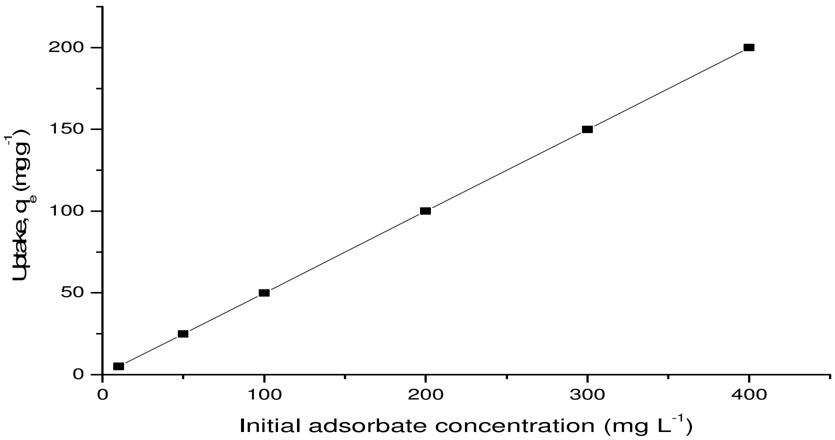

Fig. 4: The effect of initial metal ion concentration on Pb(II) uptake onto *Dacryodes edulis* seed biomass [Conditions : Contact time: 5 minutes, 50 mg of each adsorbent, pH - 5, agitation speed - 150 rpm, temperature - 28 °C].

The Pb(II) uptake ability of the *Dacryodes edulis* biomass increased rapidly from 4.839 to 199.455 mg/L with an increase in the initial metal ion concentration from 10 to 400 mg/L and a constant biomass dose of 50 mg. The Pb(II) uptake onto *Dacryodes edulis* increased with increase in the initial metal ion concentrations because increasing the initial metal ion concentration provides a driving force for mass transfer between the aqueous and bulk phase while decreasing the resistance to metal uptake (Onyancha *et al*., 2008).

The effect of biomass dose: The quantity or dose of the *Dacryodes edulis* biomass used determines the number of available free sites for metal binding. The experimental result of the uptake of Pb(II) ions onto the *Dacryodes edulis* biomass when the biomass dosage is varied is shown in Figure 5.

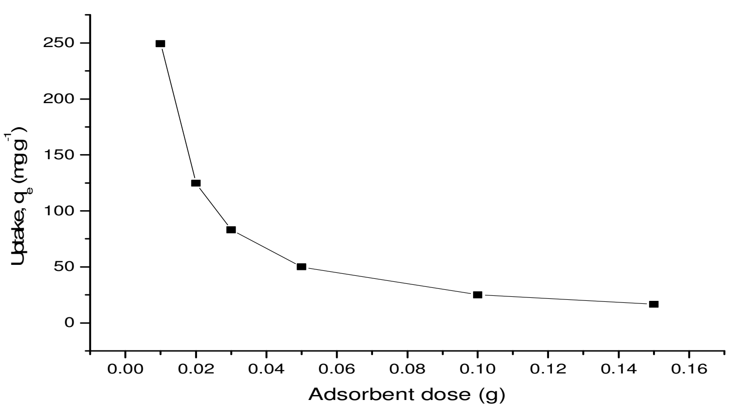

Fig. 5: The effect of adsorbent dose on Pb(II) uptake onto *Dacryodes edulis* seed biomass [Conditions : Contact time: 5 minutes, Pb^{2+} concentration – 100 mg L^{-1}, pH - 5, agitation speed - 150 rpm, temperature - 28 °C].

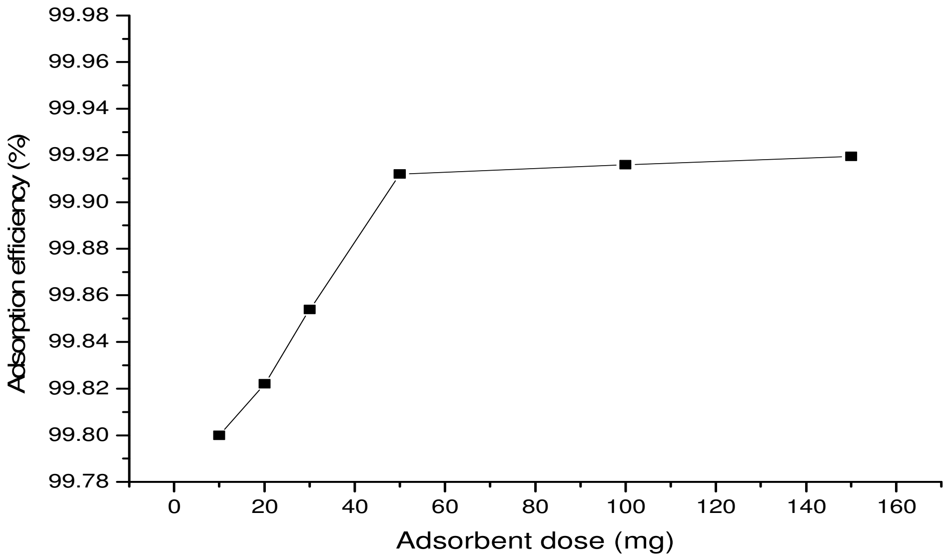

Fig. 6: The effect of adsorbent dose on the adsorption efficiency of *Dacryodes edulis* seed biomass for Pb(II) adsorption [Conditions : Contact time: 5 minutes, Pb^{2+} concentration – 100 mg L^{-1}, pH - 5, agitation speed - 150 rpm, temperature - 28 °C].

The metal ion uptake or adsorption capacity is seen to decrease with increase in biosorbent dose from 10 - 150 mg at constant Pb(II) ion concentration. This is due to the fact that more and more of the active sites were unsaturated at larger adsorbent masses since the concentration of Pb(II) was constant and not increasing.

However, biosorption efficiency increases with increase in biomass dose due to the fact that increased biomass dose means increased number of active sites and therefore increased potential for biosorption. This can be seen in Figure 6. An optimum biosorption efficiency of 99.96 % of Pb (II) occurred at a biomass dose of 150 mg.

Equilibrium modeling: Equilibrium modeling describes the relationship between the metal ion uptake q_e per biosorbent mass and the concentration of the adsorbate component in the solution at equilibrium at constant temperature. The parameters got from equilibrium modeling give important information that aids the design of adsorption systems.

Two well-known adsorption isotherms were chosen to represent the experiment data for Pb(II) adsorption onto *Dacryodes edulis* at 28 ^{o}C as shown in Figures 7 and 8. The correlation coefficient, R^2 values which were got for both the Langmuir and Freundlich isotherms indicate a good representation of the experimental data but the Freundlich isotherm fitted better (Fig. 8) with an R^2 value of 0.987. This means that the adsorption of Pb(II) ions onto *Dacryodes edulis* was a heterogenous kind of adsorption.

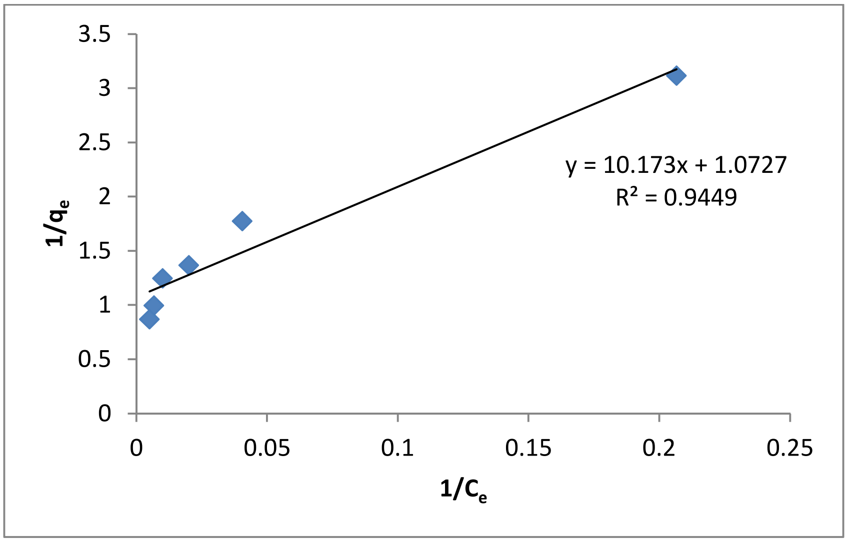

Fig. 7: *Langmuir plot for the biosorption of Pb (II) ions onto Dacryodes edulis.*

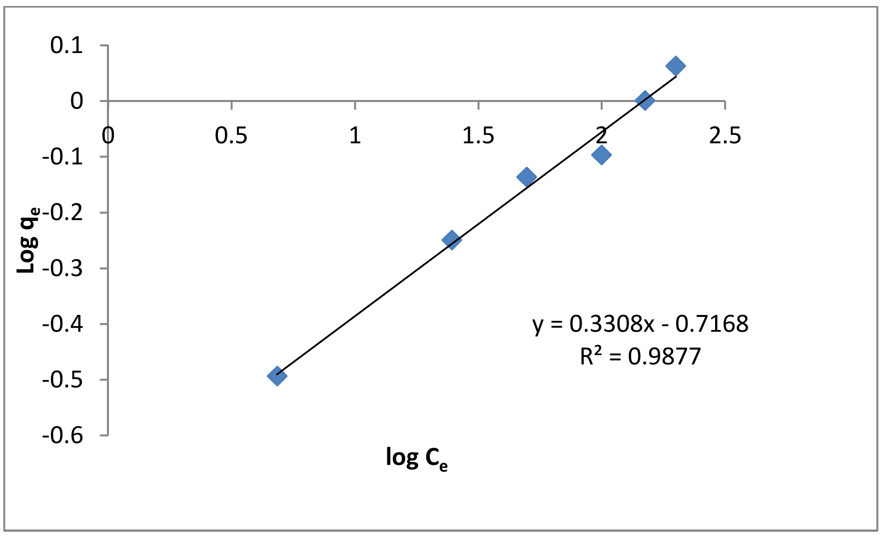

Fig. 8*: Freundlich plot for the biosorption of Pb (II) ions on Dacryodes edulis*

Table 1 shows the calculated values of the different parameters (R^2, K_L, K_F, q_{max} and n) obtained from both Langmuir and Freudlich isotherm models, where q_{max} is the maximum metal adsorption capacity, K_L is an affinity parameter known as Langmuir constant, K_F relates to adsorption capacity and n is an emperical parameter which indicates the intensity of adsorbate - adsorbent bond.

Table 1: Langmuir and Freudlich isotherm parameters for biosorption of Pb (II) onto *Dacryodes edulis*.

Langmuir isotherm			**Freundlich isotherm**			
Metal ion	R^2	q_{max} (mg/g)	K_L	R^2	K_F	N
Pb^{2+}	0.945	10.42	1.043	0.99	8.68	0.335

Adsorption kinetics: Adsorption kinetics is the most important factor which determines the rate at which adsorption occurs for a given system. Also, it aids to understand sorbent design, reactor dimension and sorbate residence time (Horsfall and Spiff, 2004).

According to Ho *et al*. (1996), adsorption kinetics depends largely on both the chemical and physical characteristics of the adsorbent. That is, the biomass features influences the mechanism of adsorption process.

In this study, the pseudo first-order and pseudo second-order kinetic models where used to test the experimental data so as to investigate the mechanism of biosorption of Pb^{2+} onto the pulverized seed of *Dacryodes edulis* and the results are presented in Figures 9 and 10. A plot of Log ($q_e - q_t$) against t gave a linear graph (Figure 9) with low correlation coefficient (R^2 = 0.814). This implies that the pseudo first-order kinetic model does not give a good fit for the biosorption of Pb(II) ions on pulverized seed biomass of *Dacryodes edulis* since the R^2 value or coefficient of correlation was significantly less than 1. Therefore, this model was not further considered.

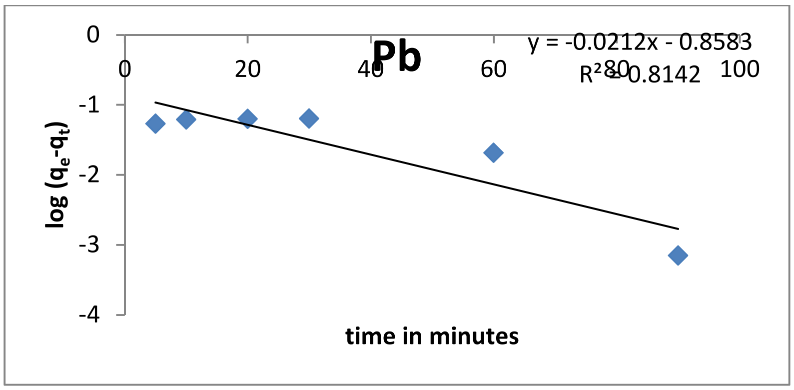

Fig. 9*: Pseudo first - order plot for the biosorption of Pb (II) ions on Dacryodes edulis.*

On the other hand, the pseudo second-order model represented by a plot of t/qt against t gave a better fit of the experimental data of Pb(II) adsorption onto *Dacryodes edulis* seed waste with R^2 value of 1 (Figure 10).

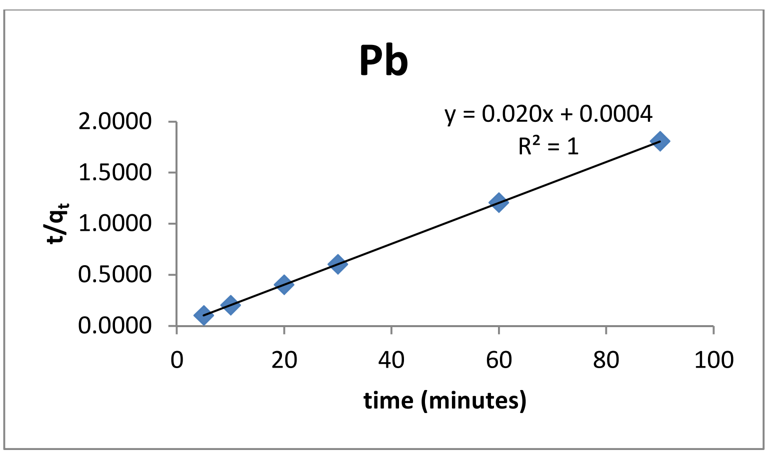

Fig.10. *Pseudo-second order plot for the biosorption of Pb (II) ions on Dacryodes edulis.*

This shows that the rate limiting steps is more of a chemical sorption process between the Pb^{2+} and the pulverized seed of *Dacryodes edulis*. This mechanism suggests that the sorption process follows the second order mechanism and not the first-order mechanism. According to Zafar *et al.* (2006), the square of the number of free sites is proportional to the rate of occupation of sorption sites.

The values of the equilibrium sorption capacity q_e, second order rate constant K_2 and R^2 values are shown in Table 2 for Pb^{2+}. The correlation coefficient obtained in this study is unity and the closeness of the experimental and theoretical q_{eq} values in table 2, suggest the applicability of the pseudo second-order kinetic model which is based on the assumption that the rate limiting step may be the chemisorption of Pb^{2+} on pulverized seed of *Dacryodes edulis* (Donmez *et al*., 1999).

Table 2: The Pseudo second order parameters for the kinetic study of Pb^{2+} biosorption on *Dacryodes edulis*

Metal	R^2	K_2 gmg^{-1}min^{-1}	q_e(calc)	q_e(expt)
Pb^{2+}	1	1.0	49.751	49.875

*Conclusion***:** Native pear seed is a promising biomass for Pb(II) ions removal as demonstrated by this research. The process was rapid and influenced by pH, biomass dose, adsorbate concentration and time.

The kinetic data clearly established the pseudo – second order model as a more appropriate model for describing the Pb(II) ion biosorption onto the seed biomass of *Dacryodes edulis.* The Freundlich model represented the adsorption of Pb(II) onto *Dacryodes edulis*, better than the Langmuir model when the experimental data were represented on both isotherms indicating that the adsorption process occurs on heterogeneous sites. However, the Langmuir isotherm investigation shows that under optimum conditions (pH 5, biomass concentration 50 mg/L; temperature 28 ^{0}C and contact time 90 minutes), a maximum biosorption capacity of 10.42 mg of Pb(II) per gram of the *Dacryodes edulis* seed biomass was obtained.

The obtained result from this research shows that the native peer seed (*Dacryodes edulis*) is an efficient biosorbent for Pb^{2+} ions removal from contaminated aqueous environment.

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