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Research Article

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Biosorption of Pb (II) from aqueous solutions using column method by lengkeng (*Euphoria logan lou*r) seed and shell

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ABSTRACT

The removal of Pb (II) from aqueous solutions was studied column adsorption systems using lengkeng's (Euphoria logan lour) seed and shell as biosorbents. The evaluated parameters were optimum pH, initial concentration, particle size and flow rate. The optimum condition was at pH=3, concentration 400 mg/l, 250 µm particle size and 2 ml/min flow rate with adsorption capacity 5,202 mg/g for lengkeng seed and 5,533 mg/g for lengkeng shell. This study revealed that Euphoria logan lour seed and shell is a very good biosorbent to remove Pb (II) from waste water as the substitutes of more expensive synthetic material.

Keywords: Biosorption, Column, Seed and Shell *Euphoria Logan Lou*r, Pb (II)

INTRODUCTION

The heavy metals in industrial waste water are hazardous to the ecosystem and possible human health. Conventional methods used to remove toxic heavy metals from aquatic environment include precipitation, filtration, Oxidation-reduction, ion exchange, liquid membrane separation(1), extraction, chemical precipitation, adsorption and electro dialysis(2; 3). Muricipal or industrial effluents treated by waste water treatment plants contain large a mounts of organic matter and pollutants including metals such as Cu, Zn, Cd and Pb(4). Lead is especially known to be the most toxic metal among heavy metals, even at low concentrations in the aquatic environment. Current USEPA drinking water standard for lead 300 µg/l when present above 0.05 mg/l in drinking water, Pb (II) is a potent neurotoxic metal(3). Lead is very toxic heavy metal. It's target organs are bones brain, blood, kidneys and thyroid glands. Presence of lead in discharge and toxic nature waters in aquatic system(4).

Research in the recent years has indicated that some natural biomaterials including agricultural products and by products can accumulate high concentration of heavy metals. Adsorbent generated from these biomass are cost effective and efficient, low cost agricultural product and by products have been reported to be effective in removing toxic metals(5). Waste Mangostreen shell(5), pomegranate(4), akke apple seed(1), banana, lemon and orange cortex (6), melon seed (7; 8), peanut shell (3), tomato waste(9), papaya seed(10) to name a few.

In this study, Lengkeng(*Euphoria Longan Lour)* shell and seed which was an agricultural waste product, were used as a biosorbent for the removal Pb (II) ions. The lengkeng shell and seed were characterized by FTIR spectroscopy to identity type a chemical bonds in molecules present in lengkeng shell and seed. For this purpose we would determine the optimum biosorption conditions as a function of pH, initial metal concentration ion, particle size, amount of biosorbent dose, and flow rate in the biosorption of Pb (II) by *Euphoria Longan Lour* with column method.

EXPERIMENTAL SECTION

In present works the biosorption experiments were conducted by using stock standard solution (1000 mg/L) of $Pb(NO_3)_2$ merck, HNO_3 65 %, NH_3.

Preparation of biosorbent

Lengkeng shell and seed (shown figure 1) were used a biosorbent for sorption of Pb(II) from an aqueous solution. Lengkeng were collected from the market of Padang city. Lengkeng were wasted with deionized water, air-dried for 7 days and ground using crusher, with particle size various 106-425µm. The lengkeng shell and seed in a solution of 0,01 M HNO_3 for 2 h with 20 g biomass in excess of 80 ml HNO_3 0,01 M, followed by washing thoroughly with deionized water and then air-dried.

Figure 1. Lengkeng seed (a), lengkeng shell (b) and fruit of fresh lengkeng

Metal biosorption experiments

Column biosorption experiments were conducted as a function of pH sorbent, dosage, particle size, initial concentration, using column sorption method.

The amount of adsorbed metal ions per gram of the biomass (Q, biosorption capacity) was obtained using the following

$$Q = \frac{C_0 - C_f}{M}\ x\ V$$

Where Q is the metal uptake (mg/g)
$C_o$is the initial metal concentrations (mg/L)
C_f is the final concentrations of metal ions (mg/L)
V is the solution volume (L)
M is mass of sorbent (g)

The percentage removal of dye and amount adsorbent (in mg/g) was calculated using the following relation ships:

$$\% = \frac{C_0 - C_f}{C_0}\ x\ 100\%$$

Column biosorption experiments were implemented in a set of conical flask containing 10 ml of solution to investigate the effects of pH (2-6). Initial metal ion concentration (40-600 mg/L), biosorbent dosage (0.2 - 0.5 g), particle size (106-425 µm) and flow rate (1-6 ml/min). Then, the suspension was filtered and metal ion concentrations in the supernatant solution were measured by Atomic Absorption Spectrophotometer. The optimum conditions for the biosorption of Pb (II) ion were determined.

RESULTS AND DISCUSSION

FTIR characterization was carried out to analysis the mayor functional group which exists in the biomass. The broad and intense peak at 3304,6 cm^{-1}[Fig.2], 3289,63 cm^{-1} [Fig.2] with ranging from 3600 to 3200 cm^{-1}, was assigned to the stretching of – OH groups due to inter and intra molecular hydrogen bonding of polymeric compound such as alcohols and carboxylic acid. At 2924, 74 cm^{-1} C-H stretching. The 1614.95 cm^{-1} (a) and 1635.02 cm^{-1} peak was a carboxyl stretch in ester.

Scanning Electron Microscopy (SEM) technique was used to examine the physical morphologies and surface properties of lengkeng (*Euphoria Longan Lour*) shells and seeds biosorbent. The textural structure examination of lengkeng particle could be observed from the SEM image at 250 x and 5000 x magnification [Fig.3].

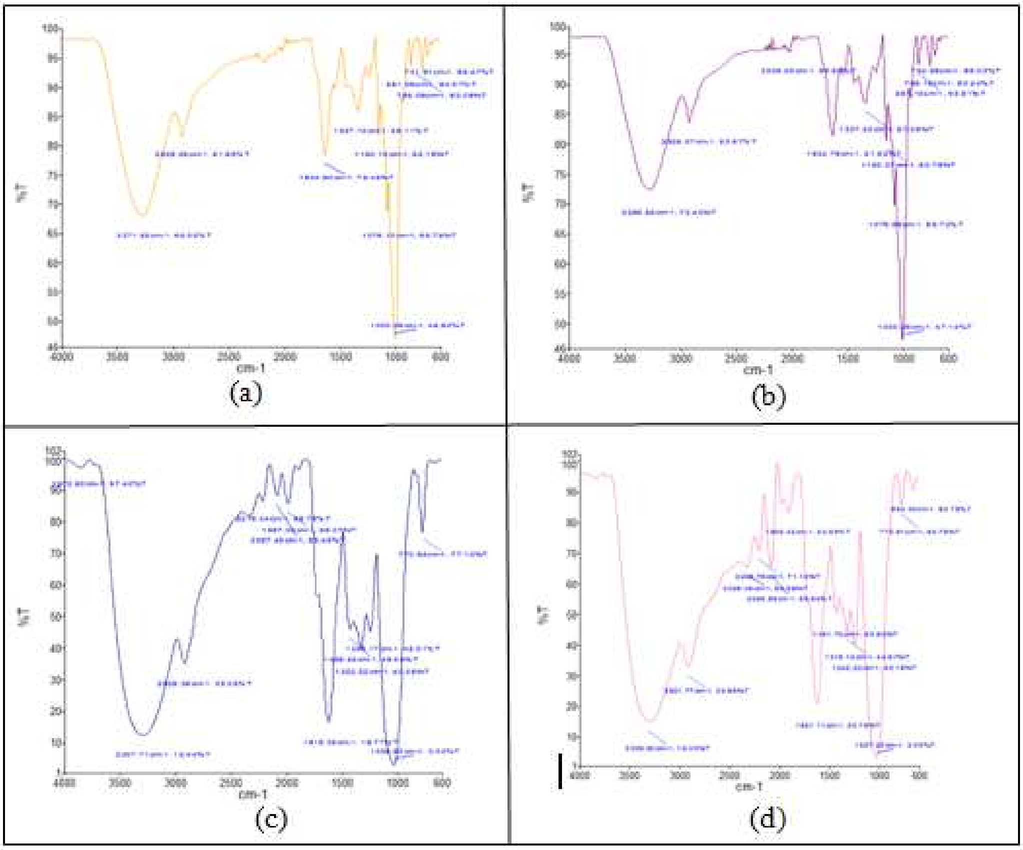

Figure. 2. FTIR Spectra of Lengkeng Seeds (a), activated Lengkeng Seeds (b), Lengkeng Shell (c) and activated Lengkeng Shell (d)

Effect of pH solution

The pH of solution had a significant impact on the removal of heavy metals since it determined the surface change of the adsorbent has carboxylate. In figure 4 was showed the maximum biosorption of Pb (II) occurred at pH 3 with biosorption capacity 0,322 mg/g at seed and 0,299 mg/g at shell. There was a decrease in biosorption capacity with increase pH from 3 to 6. Biosorption of metal ions decreased because of increasing of competition with H^+ ion for active biosorption sites at lower pH. Similar results were shown by [11] in the removal of Pb^{+2} also got the optimal pH for biosorption as 3. Gupta et all in (11) used passage, fly ash a sugar industry water material for the removal of Pb(II), the optimum pH 3.

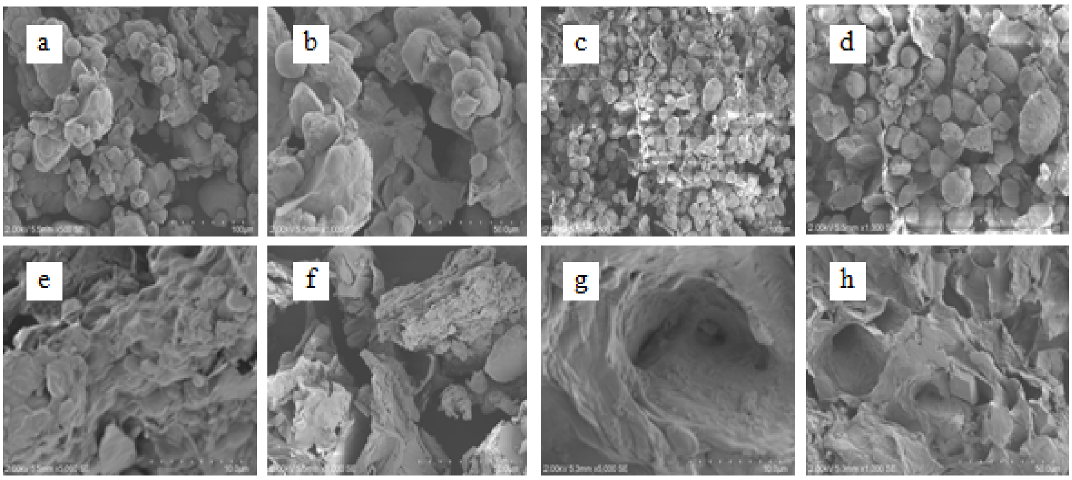

Figure 3. Scanning Electron Microscope (SEM) Image of Lengkeng seed before activation with 500-times magnification (a) 1000x (b) after activation with 500-times magnification (c) 1000x (d). SEM image of lengkeng shell before activation with 500 times magnification (e), 1000x (f) and after activation with 500-times magnification (g), 1000x (h)

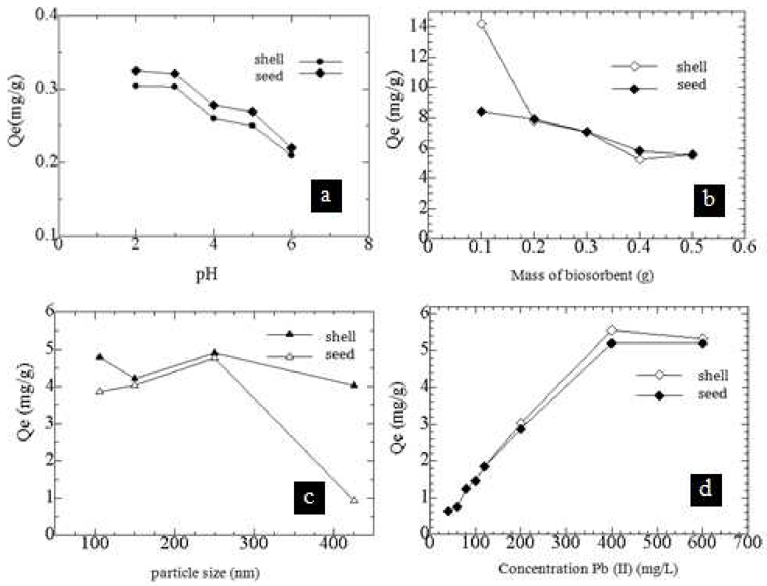

Figure 4. Effect of pH on Pb (II) biosorption by *Euphoria Logan lour* seed and shell, particle size 150 µm, mass of biosorbent 0.5 g, concentration 400 mg/L with column method (a). Effect of dose adsorbent on Pb (II) biosorption by *Euphoria logan* lour seed and shell, mass of biosorbent 0,5 g, concentration 400 mg/L, pH 3 with column method (b). Effect of particle size on Pb (II) biosorption by *Euphoria logan* lour seed and shell, mass of biosorbent 0.5 g, concentration 400 mg/L, pH 3 with column method (c). Effect of concentration on Pb (II) biosorption by *Euphoria Logan* lour seed and sheel, particle size 150 µm, mass of biosorbent 0.5 g, optimum pH 3 with column method (d)

Effect of biosorbent dosage Pb(II) biosorption

Influence of biosorbent dose on Pb (II) biosorption was examined by varying dosage from 0.2 to 0.5 g. The maximum metal biosorption capacity was attained when 0.5 g was used which is 5.45 mg/g at seed and 5.58 mg/g at shell, as shown in figure 4. The uptake capacity of metal ion per unit mass of biosorbent mg/g decreases with increase in dose of adsorbent. Fig.4 showed the heavy metal ion biosorption capacities of lengkeng (*Euphoria Longan Lour*) shells and seeds as a function of biomass dosage of Pb (II) within the aqueous solution.

Effect of initial metal ion concentration

The heavy metal ion biosorption capacities of lengkeng seed and shell as a function of the initial concentration of Pb (II) ion within the aqueous solution. The amount of metal ions adsorbed per unit mass of lengkeng shell and seed increased with an increased in initial concentration of Pb (II) ion and then decreased as shown in figure 4. At the lower concentrations, all metal ions present in the solution would interact with the binding sites and thus facilitated 100 % biosorption. At concentrations adsorption, sites took up the available metal ions more quickly. However, at higher concentrations metal need to diffuse to biomass surface by intra particle diffusion and more hydrolyzed ion will diffuse at a slower rate(12). The maximum biosorption capacity of Pb (II) per gram of lengkeng (*Euphoria Longan Lour*) shells and seeds was calculated as 5.502 mg/g at seed and 5.6 mg/g at shell metal solution (fig.4).

Effect of particle size on adsorption of Pb (II)

The adsorption of Pb (II) ion on lengkeng (*Euphoria Longan Lour*) shells and seeds in creased with decreased in particle size. Studies carried out on the effect of particle size of lengkeng (106-425 µm) on the removal of Pb (II) ions showed that capacity adsorption of Pb (II) ions increase with decrease in particle size. (Fig.4)

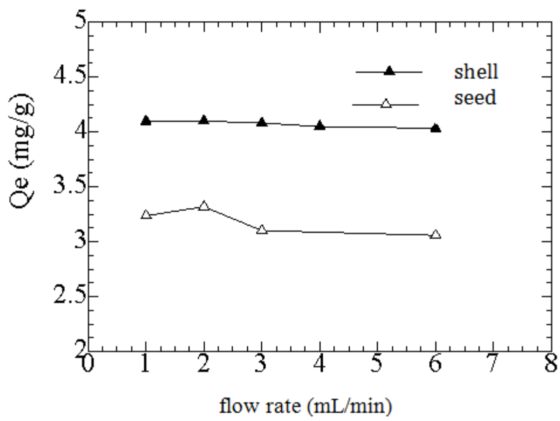

Figure 5. Effect of flow rate on Pb (II) biosorption by *Euphoria logan* lour seed and shell, mass of biosorbent 0.5 g, concentration 400 mg/L, pH 3 with column method

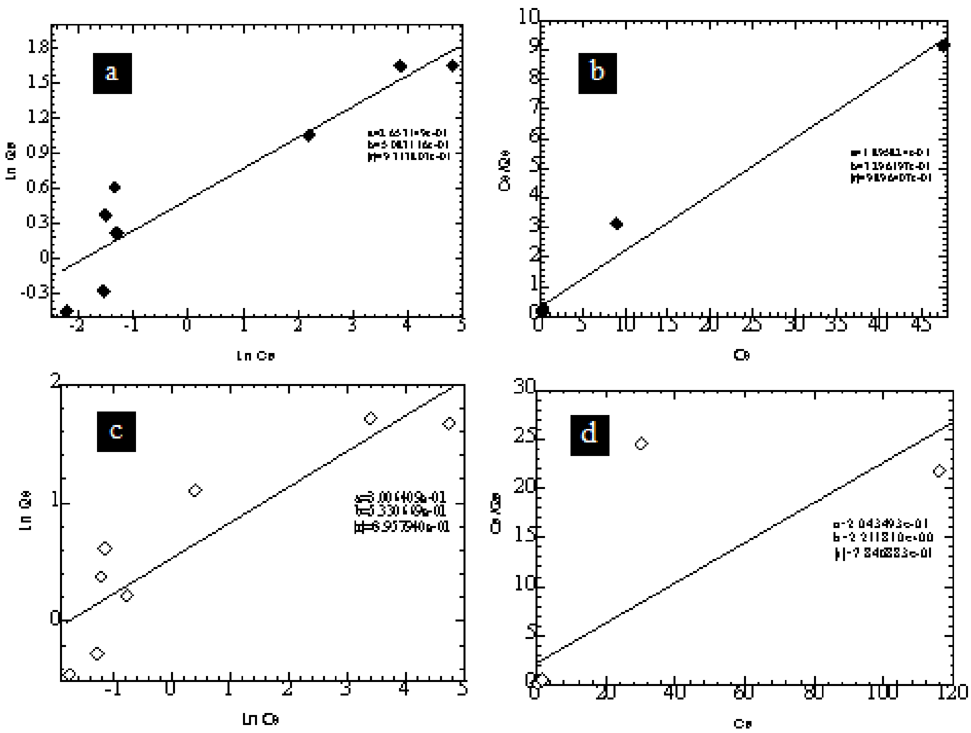

Figure 6. Freundlich Isoterm on Pb (II) biosorption by *Euphoria logan* lour seeds (a). Langmuir Isoterm on Pb (II) biosorption by *Euphoria logan* lour seed (b). Freundlich Isoterm on Pb (II) biosorption by *Euphoria logan* lour shell (c). Langmuir Isoterm on Pb (II) biosorption by *Euphoria logan* lour seed (d)

In this study, the optimal particle size produced was approximately 250 µm. The size of the smallest biomass (106 µm)does not provide good absorption and this is because the smaller the particle size the more solidified in the column so that a solution of metal ions Pb (II) which is passed more and more difficult to interact with the side active from biosorbent so little absorption capacity. Absorption capacity 4.77 mg/g at seed and 4.91 mg/g at shell.

Effect of flow rate on adsorption of Pb(II)

It was found that adsorption decreased with increased in flow rate of Pb(II) ion concentration. The maximum removal biosorption capacity at 2 ml/min with adsorption capacity 3, 32 mg/g at seed and 4.1 mg/g at shell.(Fig 5)

CONCLUSION

The results demonstrate that lengkeng shell and seeds are an effective biosorbent to remove Pb (II) from aqueous solution 5.272 mg/g for lengkeng seed and 5.533 mg/g at shell. Pb(II) was removed in coulomb experiments. Biosorption process was affectifed by pH 3, biosorbent dose 0.5 g, initial concentration 400 mg/L, particle size 250 µm and 2 ml/min flow rate with adsorption capacity 5.202 mg/g for lengkeng seed and 5,533 mg/ for lengkeng shell. The equilibrium data fitted well to Langmuir isotherm with R^2 = 0, 9943 (Fig 6). The study revealed that lengkeng biosorbent could be used as on adsorbent for the removal of other heavy metals on large scale.

REFERENCES

[1] Jimoh Oladejo Tijani, Muhammed Muhammed Ndamitso, Ibrahim Bukola Aliyu, Olakunle OS. **2013**. *International Journal of Advancements in Research and Technology* 2:1-29

[2] Adeloja O, Amoo I. A., AD A. **2011**. *Archieves of Applied Science Research* 3:50-60

[3] Seyda Tasar, Fatih Kaya, Ozer A. **2014**. *Journal of Environmental Chemical Engineering* 1018-26

[4] Muddasar Alam, Raziya Nadeem, Jilani MI. **2012**. *International Journal of Chemical and Biochemical Sciences, IJCBS* 1:24-9

[5] Rahmiana Zein, Suhaili. **2010**. *Journal of Hazardous Materials* 181:52-6

[6] Kevin Kelly Vargaj, Monica Cerro-Lopez, Silvia Reyna-Tellez, Erick R., Bandala, Sanchez-Sales JL. **2012**. *Physics and Chemistry of The Earth*:26-9

[7] Adesola Babarinde, Misore GO. **2014**. *International Journal of Chemical and Biochemical Sciences* 5:72-85

[8] ROA Adelagun, EP Barezi, Itodo A. **2014**. *Chemistry and Material Research* 6:113-21

[9] AS Yargic, RZ Yarbay Sahin N, Onal OE. **2015**. *Journal of Cleaner Production* 152-9

[10] Norhafizah binti Abd Hadi, Nurul Aimi binti Rohaizar, Sien WC. **2011**. *Asian Transsactions on Engineering* 1:49-55

[11] Meillia Innes Kurniawan, Abdullah Z. **2014**. *Asian Journal of Chemistry* 26:3588-94

[12] Hafiz Muhammad Adeel, Parven B. **2013**. *International Journal of Chemical and Biochemical Sciences*:38-45