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Effect of Cadmium in Biosorption of Lead by Lengkeng Seed and Shell (Euphoria logan lour)

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Abstract. In this study, the effect of of Cd(II) in biosorption of Pb(II) by lengkeng seed and sheel from a binary metal mixture was studied and compared with the single metal ion situation and other way. The purpose studied by the metal ion competition in the solution is to know the effect and the absorption capacity of one type of metal ion in a solution containing several metal ions inside which will be applied to the waste. The optimum conditions used were for Pb at pH 3 and Cd at pH 5 with a particle size of 250µm. The results showed a decrease in the absorption of Pb metal ions reached 42.14% (for lengkeng sheel) and 57.07% (for lengkeng seed). And decrease of Cd metal ion to 68,11% for seed and 64,77% for lengkeng shell.

Keyword: Lengkeng Seed and Sheel, Biosorption, Cadmium, Lead, Competition.

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1 Introduction

The existence of heavy metals in the environment due to industrial waste disposal containing chemicals can cause poisoning because it is toxic and dangerous if accumulated in the body, it is even possible to cause death. Heavy metal such as lead, cadmium and cobalt from the anthropogenic sources, metal plating, mining operations and other industries are among the most common pollutants found in industrial effluents, and become an environmental problem of worldwide concern. (Fourest, *et.al* , *1996* , Kratochvil , *1998)* (For this reason, before disposing it into the water, a set of process is required to be performed first. Some techniques

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that have been used to absorb heavy metals are ion exchange, precipitation, coagulation, membrane separation and adsorption (Kurniawati et al, 2015, Adeloja et al , 2011, Jimoh, et al 2013).

This method is highly expensive and ineffective because it requires huge cost in the waste treatment process. The most commonly used biosorption is the activated carbon and ion exchange resins which have high prices, therefore in this study the alternative biosorbents that are easily obtained and cheap to absorb metal ions that are used. Some researches that have been done to absorb heavy metals are the skin of the mangosteen fruit (Zein, R., et.al, 2010), durian seeds (Lestari, I., et.al, 2016), langsat fruit seeds (Wahyuni, D., et al, 2014), apple skin (Sureshet.al, 2014), melon seeds (Adelagun, et.al, 2014), soursop seeds (Kurniawan et al, 2014), tomatoes (Yargic et al, 2015), seeds longan skin (Kurniawati et al, 2015), banana, lemon and orange cortex (Kevin et al, 2012) , peanut shell (Seyda, et al, 2014), tomato waste (As, et al, 2015), papaya seed (Norhafizah, 2011) to name a few. Besides, the advantage of this biosorbent is it can be regenerated and reused (Xi et al, 2013, Gupta, et al , 2009, Wang, 2009).

The previous research has shown that longan skin seeds can absorb Pb(II) metal with the absorption capacity of 4.8933 mg/g for skin and 5.2720 mg/g for seeds (Kurniawati et al, 2015). In industrial waste, it usually contains several kinds of metals produced in the processing process and therefore it is necessary to study the effect of the existence of other metals that affect the process of absorption of Pb (II) metal ions using longan seeds and skin as biosorbent (binary metal competition) and vice versa. The aim of studying the competition of metal ions in solution is to determine the effect and absorption capacity of one type of metal ion in a solution containing several metal ions in it which will later be applied to the waste.

2. Materials and Methods

2.1. Sample Preparation

The sample used as the adsorbent for Cd and Pb metals adsorption in liquid. The seeds and the skins of the fruits are washed with the deionized water, wind-dried. The dried sample is whisked with 250 µm size. Then as much as 20 gram of longan seeds/ skin is activated by being soaked in 80mL of HNO3 0.01M for 2 hours and neutralized with aquades, then wind-dried (Kurniawati et al, 2015).

2.2. The materials used

The longan skin and seeds obtained from the Padang market, silver nitrate crystals ($Pb(NO_3)_2$), Metal Cd, nitric acid ($HNO_3$65%), NaOH, NH_4OH.

2.3. The Effect of the Competition of Pb(II) and Cd(II) Ions

0.5 gram of biomass is inserted into the column, added 10 ml of a solution of Pb(II) and Cd(II) ions with various concentrations:

a. The concentration of Pb(II) 200 mg/ L and the concentration of Cd(II) were varied between 50, 100, 150 and 200 mg/ L. In binary solutions this is carried out under optimum conditions for absorption of Pb(II) metal. After the absorption using longan seeds and skin as biosorbent is done, then the filtrate is collected and analyzed for absorption of Pb(II) ions using AAS.

b. The Cd(II) 200 mg/ L concentration and Pb(II) concentration varied between 50, 100, and 150 mg/ L. In binary solutions this is carried out under optimum conditions for metal absorption Cd(II). After the absorption using seeds and longan skin as biosorbent, then the filtrate is collected and analyzed for absorption of Cd(II) ions using AAS.

3. Results And Discussion

3.1. The Mixture of the Metal Ions Cd(II) and Pb(II)

The competition between metal ions Cd(II) and Pb(II) on the skin and seeds of longan fruit was studied using a solution containing Cd(II) and Pb(II) ions, then each of the metal ions was measured for their absorption capacity and for the effect of ion addition other metals to biosorbent absorption capacity. The results of the study are shown in Figure 1, that the maximum absorption capacity of single Pb(II) ions is 5.5450 mg/ g, when Pb(II) ions are mixed with Cd(II) ions with variations in concentrations of 50, 100, 150 and 200 mg/ L, the result obtained was the ion absorption capacity of Pb(II) was 3.5303; 3.4772; 2,3807; and 3.4099 mg/ g. So the existence of metal ions Cd(II) in solution can cause a decrease in the absorption capacity of Pb(II) ions in longan fruit seeds, but the addition of Cd(II) ion concentrations in the solution does not give a significant difference in the absorption capacity of Pb(II) ions. This is because Pb(II) and Cd(II) ions are absorbed on the active side that are different from biosorbent.

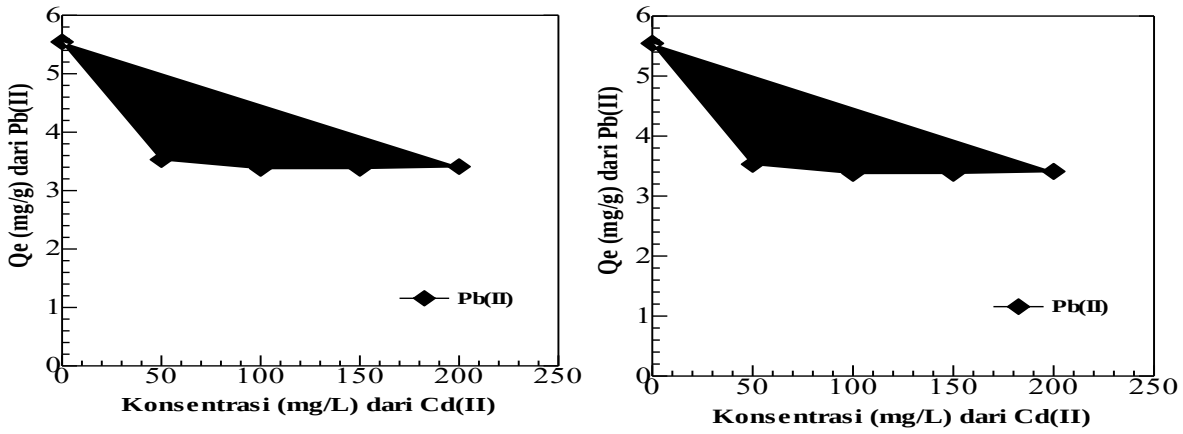

Figure 1. The Effect of metal ion Pb(II) with the existence of Cd(II) in longan seeds; the concentrations of Pb(II) 200mg/ L, Cd(II) = 50, 100, 150, 200 mg/L

The similar matter can also be seen in Figure 2, where the absorption capacity of metal ion Pb(II) on longan skin experienced decrement after the presence of Cd(II) ions in the solution,

which was 5.5850 mg / g to 3.489; 3.3792; 3.2684 and 3.2316 mg/ g, but the difference in absorption capacity of Pb(II) ions was not significant with the increase in the concentration of Cd(II) ions added to the solution. So the addition of Cd(II) ions to the solution does not affect the absorption capacity of Pb(II) by skin or Cd (II) which is added to non-competitive Pb(II) to bind the active side. This is in accordance with the study of Mahamadi and Nharingo (2010) who studied the competitive adsorption of Pb(II), Cd (II) ions in water hyacinth in a binary and ternary system.

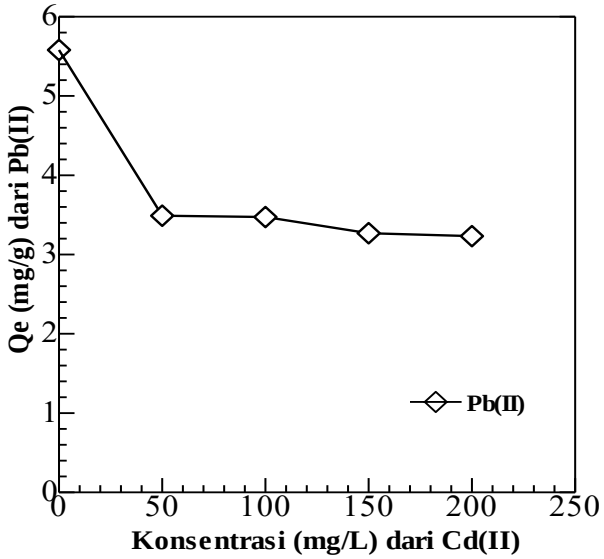

Figure 2. The Effect of metal ion Pb(II) with the existence of Cd(II) in the longan skin; Pb(II) concentration of 200mg/L, Cd(II) = 50, 100, 150, 200 mg/ L.

3.2. The Mixture of Metal Ion Pb(II) and Cd(II)

The effect of the mixture of metal ion Pb(II) and Cd(II) on the absorbent capacity by the longan seeds. From the figure, it is known that the absorbent capacity of the metal ion Cd(II) before the addition of the metal ion Pb(II) in the solution which is 3.2900 mg/g. Then it experienced a decrease by the addition of the metal ion Pb(II) in the solution with the variation of concentration of 50, 100 and 150 mg/ L with the absorbent capacity of 2.931; 2.771; and 1.049 mg/ g, however there is an increment of the absorbent in the addition of Pb(II) ion with the concentration of 200mg/ L to become 2.307 mg/g.

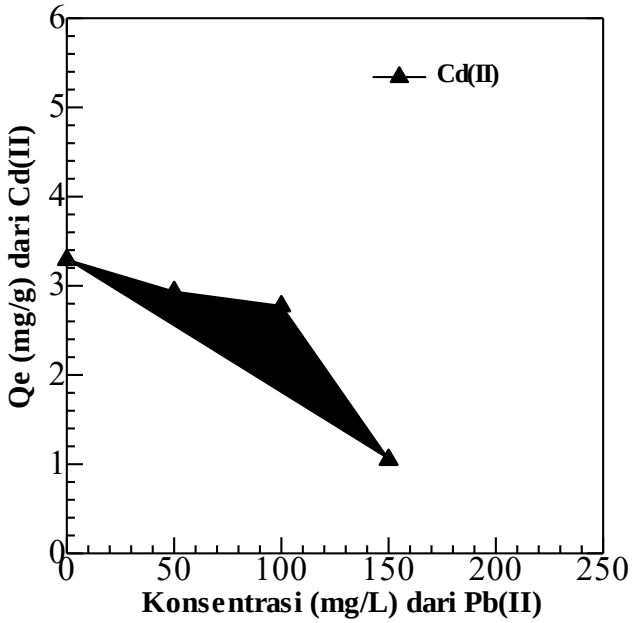

Figure 3. The Effect of the metal ion Cd(II) with the existence of Pb(II) in longan seeds; the concentration of Cd(II) 200mg/L, Pb(II) = 50, 100, 150, 200mg/ L

The same condition is also shown in Figure 4 that the mixture of the metal ion Cd(II) and Pb(II) in the solution affects the absorbent capacity by longan skin, then it can be said that the occurrence of the competition of the metal ion Cd(II) and Pb(II) in the binding of the active side in the biosorbent of longan skin and seeds. According to Yu et al (2013), Pb(II) ion is the metal that atom mass of more than (207.2), paramagnetic, is the ion with excessive electronegative (Pb2+ (2.33) >Cd2+(1.69)) and has the smaller ion radius of (Pb2+ (0.401 nm)> Cd2+ (0.426 nm)), based on those characteristics, then Pb(II) ion is absorbed more in the carboxylic functional group of longan skin and seeds.

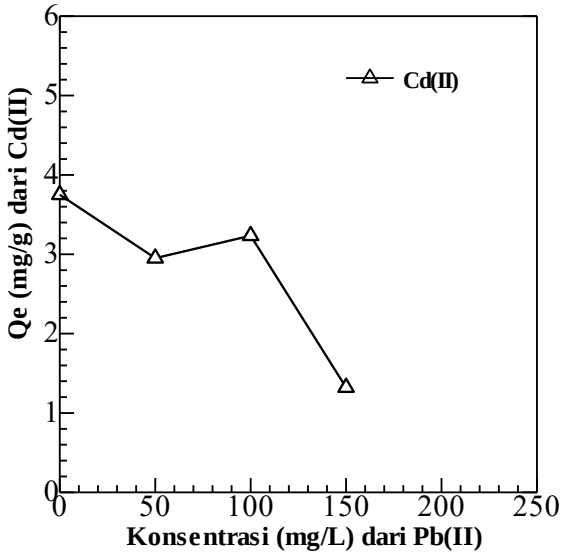

Figure 4. The effect of the metal ion Cd(II) with the existence of Pb(II) in longan skin; concentration of Cd(II) 200mg/L, Pb(II) = 50, 100, 150, 200mg/L.

In the picture above, it is displayed that the absorbent capacity on the metal ion Cd(II) in longan skin before the addition of metal ion Pb(II) in the solution that is 3.750mg/g. Then it experienced decrement with the addition of the metal ion Pb(II) in the solution with the variation of concentration of 50, 100 and 150 mg/L with the absorbent capacity of 2.9505; 3.2345; and 1.321 mg/g, however there is increment of the absorbent on the addition of Pb(II) ion with the concentration of 200mg/ L to become 2.8735 mg/g.

4. Conclusion

The binary combination of Pb(II) and Cd(II) in the absorbent using longan skin and seeds as the biosorbent highly affecting the absorption process. This condition is the result of the effect of the active side of the biosorbent to bind each different metal ion and the occurrence of the competition between the metal ion Pb(II) and Cd(II) in the absorption process. It is recommended to conduct the absorption of the metal ions in three, four or even more mixture of metal ions.

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