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Effect of Contact Time on Biosorption of Pb(II) Metal Ions Using Biosorbent from Durian Peel (Durio zibethinus L)

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ABSTRACT

Lead metal (Pb^{2+}) is a heavy metal that is dangerous and has high toxicity. Pb^{2+} metal comes from industrial waste such as electroplating, paint, and textile industry so it can find air. An effective, efficient and economical method to overcome air contact with the biosorption method. Pb^{2+} metal ion biosorption using durian peel (Durio zibethinus L) as biosorbent. The purpose of this study was to determine the optimal conditions for the absorption of Pb^{2+} metal ions using the batch method with variations in speed and stirring time. The results showed that the optimal condition for Pb^{2+} absorption occurred at a contact time of 60 minutes with an absorption capacity of 33.6163 mg/g.

Keywords: Biosorption, Pb^{2+} metal, Durio zibethinus L, Batch method

1. INTRODUCTION

Waste that usually exists in waters is heavy metals, which are very risky for living things because they can disrupt habitats and aquatic ecosystems, substances that are toxic and carcinogenic.[1] Toxic and hazardous waste that causes environmental pollution generally comes from industrial waste such as the electroplating industry (metal coating), revaration and recharging of electric current (battery), paint industry, textile industry and cosmetic industry. Heavy metals such as Cu, Zn, Cr, Cd, Ni, and Pb are often used in the industry which are very dangerous for living things.[2]

Lead is one of the most toxic heavy metals that even in low concentrations can cause poisoning to human health and other forms of life. Lead is the most toxic heavy metal that greatly affects the environment. The presence of heavy metals in watercourses is very harmful to the environment, poses a potential risk to human health and causes harmful effects to organisms living in the water as well as to consumers. Lead can cause various dangerous diseases such as anemia, kidney and liver disease, gastrointestinal damage, neurological disorders, and can even cause death. Therefore, it is important to remove Pb(II) from wastewater before disposal. The permitted level of Pb in raw water according to PP No. 82 of 2001 is 0.025

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mg/L. The Pb content of this raw water has exceeded the maximum level for drinking water, therefore processing techniques are needed to reduce Pb levels in raw water.[3]

Methods that have been carried out to overcome the problem of heavy metal ion levels in wastewater are biosorption, coagulation, electrolysis, electrocoagulation, precipitation, ion exchange, membrane separation, chemical oxidation, and other method.[4] The presence of ions other than Pb(II) in the solution causes competition between these ions to be adsorbed onto the surface of the adsorbent. Processes for the separation of metal ions in general require expensive costs with low effectiveness when applied at low concentrations in research. Methods for effective, efficient and economical alternative heavy metal waste treatment are urgently needed until now.[5] One of the alternatives used by the author in the treatment of waste containing heavy metals is by carrying out a biosorption process that uses biological materials, as adsorbents. The biosorption process is used to demonstrate the ability of biomass to bind heavy metals from the solution, through chemical or metabolic and physical steps. The use of this biosorption process has several advantages, namely the cost used is relatively cheaper, minimizes sludge formation, and the regeneration process is easy.[6]

One of the materials that can potentially be used in this biosorption process is durian skin. Chemically, durian peel has the main component in the form of fiber which contains cellulose, polyose groups such as hemicellulose, lignocellulose and lignin. In addition, durian peel also contains essential oils, flavonoids, saponins, cellulose, lignin, carbon and starch content.[7] Based on research, durian skin contains material that is composed of high cellulose (50%- 60%) and lignin (5%) and low starch (5%) .[8]

2. EXPERIMENTAL

2.1. Chemicals, Equipment and Instrumentation

The tools used in this study were beaker, mortar, pestle, porcelain dish, oven, filter paper, magnetic stirrer (MR Hei Standart), sieve (200 , desiccator, analytical balance (ABS 220-4), shaker (model: VRN-480), pH meter (Schott instrument Lab 850), spray bottle, FTIR (PerkinElmer), and AAS (Varian).The materials used in this study were durian peel, $Pb(NO_3)_2$, HNO_3 65%, NaOH and aquadest.

2.2. Research Procedure

The first stage, we do sample preparation Durian peel used in fresh condition, not rotten or blackened. Wash with running water to remove dirt that sticks to the durian peel. The durian peel is then cut into small pieces to facilitate the drying process.

Durian peel is dried in the sun for several days, then in an oven at 80°C for 48 hours. Then cooled in a desiccator for 15 minutes, the dry biomass was then blended so that it became powder.

The second stage, the durian peel that has become powder is filtered using a 200-sized sieve. The sifted durian powder was then activated by taking 25 grams of durian powder and then adding 250 ml of 0.5 M NaOH solution (1:10), allowed to stand for 24 hours. After that it was filtered using filter paper in order to separate the filtrate and residue. The residue (durian peel powder) was washed with distilled water until the pH was neutral. Then it was dried in an oven at 80°C for 30 minutes. The characterization of durian peel powder before and after activation was tested using the FTIR instrument.

The third step is to determine the effect of contact time on Pb^{2+} ion adsorption. A total of 25 ml of Pb^{2+} ion solution with optimum conditions of pH 2, concentration of 360 ppm, and speed of 150 rpm. Each ionic

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solution was contacted with 0.20 grams of activated durian peel powder, then shaken for 30, 60, 90, 120, and 150 minutes. The solution was filtered and the filtrate was collected. The resulting filtrate was then measured the concentration of the unabsorbed Pb^{2+} metal using an atomic absorption spectrophotometer (AAS).

3. RESULTS AND DISCUSSION

3.1. Characterization FTIR

Durian peel powder biosorbent (Durio zibethinus L) was analyzed by FTIR to determine the functional group bound to the Pb(II) ion. The following are the results of FTIR samples before activation, after activation and after contact.

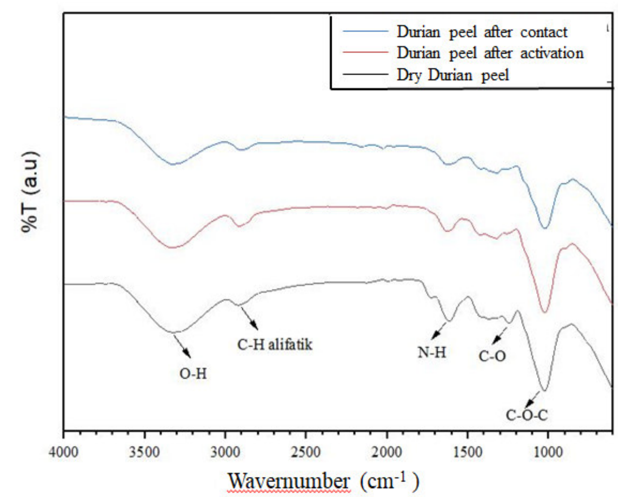

Figure 1. Durian skin spectrum before activation, after activation and after contact

The characterization of the FTIR instrument in this study was carried out by detecting the structure of a compound molecule by identifying the functional groups that compose the compound and using a wave number of 4000 – 600 cm^{-1} . In this test, the durian skin sample that was not activated was carried out to determine the functional groups present in the durian peel (Durio zibethinus L). The activated durian peel sample was tested to determine the structural changes that occur in the durian peel (Durio zibethinus L) and the contacted durian peel sample was tested to determine what functional groups play a role in binding Pb(II) metal and determine the occurrence of Pb(II) metal. biosorption process based on wavenumber shift.[9]

Based on the results in Figure above, the infrared spectral wave number on the durian peel shows the vibration of the hydroxyl group (O-H) identified at a wave number of 3328.16 cm-1 with a transmittance value of 78.30%. The hydroxyl group contained in cellulose is able to bind Pb (II) metal and then there is a stretch of alkyl group (-CH) at a wave number of 2921.35 cm^{-1} with a transmittance value of 90.64%, this indicates a stretching vibration in the range of wave numbers. 3000-2800 cm^{-1} which is a constituent of the lignocellulosic framework in biomaterials. The amine group (N-H) at wave number 1614.79 cm^{-1} with a transmittance value of 83.40% which indicates the occurrence of stretching vibrations. The carbonyl group (C-O alcohol) at wave number 1244.93 cm^{-1} with a transmittance value of 82.54% and the ether group (C-O-C) at a wave number of 1026.00 cm^{-1} with a transmittance value of 51.62%.

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In the durian peel that has been activated, it can be seen in Figure above that the durian peel biosorbent that has passed the activation stage using NaOH can affect changes in functional groups that cause a shift in wave number. In the shift in wave number there is an insignificant change but there is a slight shift in the absorption band. In the hydroxyl group (O-H) there was a shift in wave number to 3333.37 cm^{-1} with a transmittance value of 78.98%. The absorption of this group is smaller than that of the O-H group on the durian peel before being activated because the transmittance value (%T) is greater. The transmittance value is inversely proportional to absorption, the greater the transmittance value, the smaller the absorption. This indicates that the durian peel biosorbent pores have been opened after activation using NaOH. Furthermore, the alkyl group (-CH) at wave number 2915.29 cm^{-1} with a transmittance value of 88.70%, amine group (N-H) at a wave number of 1625.48 cm^{-1} with a transmittance value of 86.40%. The carbonyl group (C-O alcohol) at a wave number of 1324.21 cm^{-1} with a transmittance value of 83.17% and an ether group (C-O-C) at a wave number of 1024.99 cm^{-1} with a transmittance value of 49.85%.

In the durian peel test (Durio zibethinus L) which has been activated, contact with lead (Pb^{2+}) also experienced a shift in wave number. Contact with Pb^{2+} resulted in a shift of the hydroxyl group (O-H) to 3339.55 cm^{-1} with a transmittance value of 86.32%. The absorption is relatively small compared to %T in durian peel after activation because there has been an interaction between Pb^{2+} metal ions and the active group contained in the durian peel biosorbent (Durio zibethinus L). Furthermore, the alkyl group (-CH) shifted to 2915.52 cm^{-1} with a transmittance value of 93.42%. The shift in the amine group (N-H) with a wave number of 1630.29 cm^{-1} with a transmittance value of 86.54%. The carbonyl group (C-O alcohol) at wave number 1326.21 cm^{-1} with a transmittance value of 85.63% and the ether group (C-O-C) at wave number 1023.42 cm^{-1} with a transmittance value of 43.93%.

3.2. Effect of Contact Time

The contact time between the biosorbent and the adsorbate greatly affects the efficiency of the biosorption process. This contact time variation aims to see how long the optimum time for Pb metal can be maximally adsorbed by durian peel biosorbent. The effect of contact time was carried out on variations of 30, 60, 90, 120, and 150 minutes.

In the picture above, the contact time of 60 minutes shows the optimum time for absorption of Pb^{2+} using durian peel biosorbent (Durio zibethinus L) with an absorption capacity of 33.6163 mg/g and an absorption percentage of 87.59%. The amount of biosorbate adsorbed on the surface of the biosorbent increases with increasing contact time required to reach the equilibrium point. When equilibrium is reached, the surface of the biosorbent is completely covered by the adsorbed biosorbate, and the biosorbent reaches a saturation point so that it can no longer absorb the biosorbate [4]. The decrease in the absorption capacity of Pb^{2+} using durian peel (Durio zibethinus L) was due to the active site of the biosorbent being saturated, namely desorption. Desorption is the active side of the durian peel biosorbent which has been saturated causing the biosorbent to no longer absorb biosorbate. In addition, there is also an unstable bond between the biosorbent and Pb^{2+} metal ions which results in disruption of the bond so that the Pb^{2+} metal is released. According to research by Kamar (2017), the optimum contact time is 120 minutes in the biosorption of Pb^{2+} solution using cabbage leaf powder.[10]

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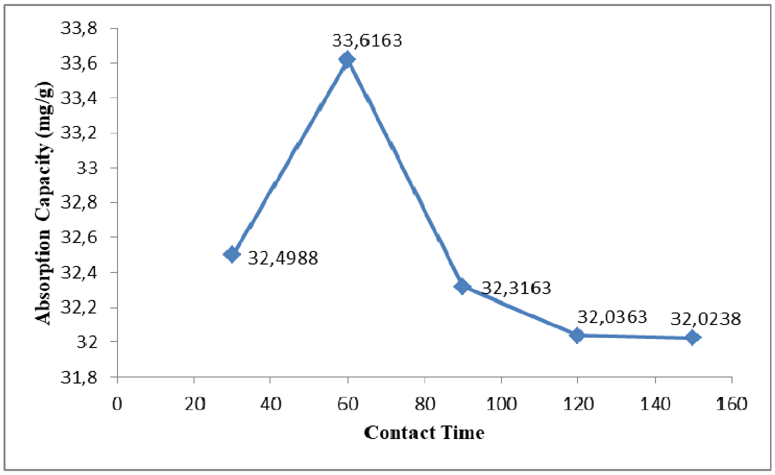

Figure 2. Effect of contact time on adsorption capacity

In the picture above, the contact time of 60 minutes shows the optimum time for absorption of Pb^{2+} using durian peel biosorbent (Durio zibethinus L) with an absorption capacity of 33.6163 mg/g and an absorption percentage of 87.59%. The amount of biosorbate adsorbed on the surface of the biosorbent increases with increasing contact time required to reach the equilibrium point. When equilibrium is reached, the surface of the biosorbent is completely covered by the adsorbed biosorbate, and the biosorbent reaches a saturation point so that it can no longer absorb the biosorbate [4]. The decrease in the absorption capacity of Pb^{2+} using durian peel (Durio zibethinus L) was due to the active site of the biosorbent being saturated, namely desorption. Desorption is the active side of the durian peel biosorbent which has been saturated causing the biosorbent to no longer absorb biosorbate. In addition, there is also an unstable bond between the biosorbent and Pb^{2+} metal ions which results in disruption of the bond so that the Pb^{2+} metal is released. According to research by Kamar (2017), the optimum contact time is 120 minutes in the biosorption of Pb^{2+} solution using cabbage leaf powder.[10]

4. CONCLUSION

Based on the research that has been done, it can be concluded that the optimum conditions for the absorption of Pb (II) metal ions on the effect of contacting durian skin samples with Pb (II) metal ions at a contact time of 60 minutes with an absorption capacity of 33.6163 mg/g and an absorption percentage of 87 ,59%.

REFERENCES

1. Kurniasari, L. (**2010**). Pemanfaatan Mikroorganisme Bahan Baku Biosorben Logam," *Pemanfaat. mikroorganisme dan Limbah Pertan. Sebagai Bahan Baku Biosorben Logam Berat*, vol. 6, no. 2, pp. 5–8.
2. Zaini H. and Sami, M. (**2016**). Kinetika Adsorpsi Pb (II) Dalam Air Limbah Laboratorium Kimia Menggunakan Sistem Kolom Dengan Bioadsorben Kulit Kacang Tanah. *Semin. Nas. Sains dan Teknol.*, no. November 2016, 2460 – 8416, pp.1-9,
3. El-Naggar N. E. A., Hamouda R. A., Mousa I. E., Abdel-Hamid M. S., and Rabei, N. H. (**2018**). Biosorption optimization, characterization, immobilization and application of Gelidium amansii biomass for complete Pb^{2+} removal from aqueous solutions," *Sci. Rep.*, vol. 8, no. 1, pp. 1–19.

4. Adriansyah R., Restiasih E. N., and Meileza N. (**2018**). Biosrpsi Ion Logam Berat Cu(II) dan Cr(VI) Menggunakan Biosorben Kulit Kopi Terxantasi. *ALOTROP, J. Pendidik. Dan Ilmu Kim.*, vol. 2, no. 2, pp. 114–121.
5. Wardani G. A. and Wulandari W. T. (**2018**). Pemanfaatan Limbah Kulit Pisang Kepok (Musa acuminate) sebagai Biosorben Ion Timbal(II). *J. Kim. Val.*, vol. 4, no. 2, pp. 143–148.
6. Ali S., La Nafie N., and Taba P. (**2019**). Biosorption Of Cu (Ii) Metal Ions By Dragon Fruit Skin (Hylocereus polyrhizus). *J. Akta Kim. Indones. (Indonesia Chim. Acta)*, vol. 11, no. 1, p. 21.
7. Zikra Nuvicha Rizkqi Y. S. R., Chairull. (**2016**). Adsorpsi Ion Logam Pb Dengan Menggunakan Karbon Aktif Kulit Durian Yang Teraktivasi. *Jom FTEKNIK*, vol. 3, pp. 1–8.
8. Febriansyah B., Chairul, and Yenti S. R. (**2015**). Pembuatan Karbon Aktif Dari Kulit Durian Sebagai Adsorbent Logam Fe. *Jom Fteknikteknik*, vol. 2, no. 2, pp. 1–11,
9. Irawati H., Aprilita N. H., and Sugiharto E. (**2018**). Adsorpsi Zat Warna Kristal Violet Menggunakan Limbah Kulit Singkong (Manihot esculenta). *Bimipa*, vol. 25, no. 1, pp. 17–31.
10. Kamar F. H., Nechifor A. C., Nechifor G., Al-Musawi T. J., and Mohammed A. H. (**2017**). Aqueous Phase Biosorption of Pb(II), Cu(II), and Cd(II) onto Cabbage Leaves Powder," *Int. J. Chem. React. Eng.*, vol. 15, no. 2.

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