Decrease of lead levels of leachate with banana skin adsorbent

N B Sumanik1, E Nurvitasari1, R Z Maarebia1 and J Langkong2

1Department of Chemistry Education, Faculty of Teacher Training and Education, Universitas Musamus, Merauke, Indonesia
2Departement of Agricultural Technology, Faculty of Agriculture, Universitas Hasanuddin, South Sulawesi, Indonesia

E-mail: sumanik_fkip@unmus.ac.id

Abstract. The purpose of this study was to provide an alternative by using banana peel adsorbent in reducing lead (Pb) levels in leachate and to find out which types of banana peels were most effective in reducing lead (Pb) levels in leachate. This study uses three types of banana Kepok, ambon, and cavendish. The material was analyzed using atomic absorption spectrophotometry (AAS) and analyzed using the adsorption capacity equation. The results showed that the largest adsorption capacity was adsorbent from Kepok banana peel with an adsorption capacity of 23 mg/g.

1. Introduction
Waste is a major problem faced by communities, especially in urban areas. Increasingly increasing environmental pollution is in line with the development of Science and Technology [1]. The rapid progress of all sectors of society, causing increased community activities. This increase causes the volume of waste to increase so that the landfill at the Final Processing Site (TPA) increases and will have an impact on the difficulty of controlling leachate. Garbage will experience decomposition that occurs naturally and dissolved in the landfill that will cause leachate [2]. The impact caused by the accumulation of waste is very dangerous for humans because the garbage can accumulate in the form of substances that are far more dangerous, a method is needed to control it.

Leachate is liquid waste caused by the entry of external water (rainwater) into landfills that can dissolve the material in the heap so that it has a variety of materials/compounds, such as organic compounds and inorganic compounds [3]. Leachate can flow and seep through the soil and it is possible to contaminate groundwater around the landfill site. If the groundwater is polluted, the groundwater will contain a lot of substances that are quite harmful to the environment and human health. Leachate water contains chemicals that can contaminate groundwater, especially if it enters the human body that consumes groundwater. So the need for the role of TPA in reducing the occurrence of landfill waste [4].

The harmful substances in leachate are lead (Pb). Lead is a type of heavy metal that is dangerous because this element is very risky to blood vessels and can cause cancer. Generally, lead (Pb) is used in the battery, cable, gilding, pesticide industry, as an anti-knocking agent for gasoline, as a pipe connecting formulation. The presence of lead in this environment is due to the accumulation in the chain food [5]. Dalam In overcoming the presence of lead metal which is harmful to the environment, several methods can be used to reduce the concentration of heavy metals, one of which is the alternative to using adsorbents from natural ingredients. Adsorption is the most commonly used
method because it has a simpler concept, does not cause toxic side effects, can be regenerated, and is more economical. Heavy metal adsorption techniques have been carried out using various kinds of adsorbents, one of which was carried out by Abraham Rettob who used adsorbents made from iron sand to adsorb \([AuCl]\) [6] Another example in the previous study used an adsorbent made from banana peels including [7, 8, 9].

Banana is a fruit that grows in groups. This plant is included in the family Musaceae which lives in the tropics with various types, ranging from Ambon banana, Cavendish banana, kapok banana and various other types of bananas. In Indonesia, bananas are the third largest commodity in the agricultural sector, after onion and cassava. Banana production in Indonesia is around 6.7 million tons of matrix produced during the year [10]. So far, the utilization of banana trees is only limited to fruit, stems, flowers, and leaves, even though there are still banana parts that can be utilized, one of which is banana peels. The skin of bananas is mostly used as unused waste and thrown away. Even though this waste is biomass that was originally a derivative from a banana that has been taken from the skin of the banana. Banana skin can bind heavy metal ions contained in leachate. This is because banana peels contain various kinds of active groups such as hydroxyl groups (-OH), carboxylic groups (-COOH), and amine groups (-NH\(_2\)) [5].

There are some previous studies about the use of banana peel adsorbent including Kepok (\textit{Musa acuminate}) banana peel waste as iron (fe) and lime (CaCO\(_3\)) [11], adsorption of Pb (II) metal ions using Kepok banana skin (\textit{Musa Paradisiaca} Linn)[5], Adsorption Lead (Pb) And Zinc (Zn) From Its Solution Using Biocharcoal, Kepok Banana Skin based on pH variations [12]. Based on previous studies using only one type of banana, which is kapok banana, even though bananas have many types, especially those grown in Indonesia, one of them is Ambon banana and Cavendish banana. Therefore the researchers wanted to examine the types of bananas which were most effective in decreasing lead (Pb) levels in leachate.

2. Methods

2.1. Research materials and materials the research

The material used was leachate from the Supiturang Malang landfill, Kepok banana peel waste, Ambon banana, Cavendish banana, aqueous HNO\(_3\) 8M. The tools in this study include measuring cups, beaker glass, ovens, blenders, desiccators, hotplates, magnetic stirrers, sieves, stopwatches, digital balance, AAS atomic absorption spectrometers in the process of determining lead metal content (Pb).

2.2. Procedure

2.2.1. Banana skin adsorption preparation. Kepok banana skin, Ambon banana, and Cavendish banana are cut to small size, then washed with tap water and distilled water. Each banana skin is placed on a different baking sheet, then in the oven at 180\(^\circ\)C for 3 hours in 2 days. The banana skin is then blended to the desired sieve size and stored in the de-indicator. The result is put in a closed airtight container or jar.

2.2.2. Analysis of the content of Lead metal (Pb). A sample was 100 mL leachate put in a beaker, then filtered by vacuum. The resulting filtrate is then included in the wet destruction process. This process is carried out in an acid chamber by adding a filtrate with 5 mL HNO\(_3\) 8M and closing the glass mouth with a watch glass and heating it on a hotplate until the volume becomes 20 mL with a temperature of 300\(^\circ\)C. The results are put into a 50 mL Erlenmeyer flask, then added with distilled water to the boundary mark and mixed until homogeneous. After that, the analysis was carried out using the atomic absorption spectrophotometry (AAS).
2.2.3. The lead metal adsorption (Pb) process using adsorbent. 100 mL leachate put into 3 beakers which have been labeled differently (glasses A, B, C), then added to each glass with 1 gram of different adsorbent (Glass A by adsorbing Kepok banana peel, Gelas B with the adsorbent of Ambon banana skin, and Gelas C with the adsorbent of Cavendish banana skin). After addition, stirring for 60 minutes is done with a glass spatula stirrer (manual). Then filtering is done with a vacuum device, until a filtrate is obtained which will enter the destruction process. In the process of destruction, the filtrate is given the same treatment as the sample in the analysis of Lead (Pb) metal content in the sample. Then the results of destruction are analyzed using AAS.

2.3. Data analysis method
The data obtained, can be calculated the adsorption capacity of lead metal ions (Pb) using the formula:

\[ q = \frac{(C_o - C_e)}{m} \times V \]

Information:
q = adsorption capacity of banana skin adsorbent against metal ions Lead (Pb) (mg/g)
Co = initial concentration (mg/L)
Ce = final concentration (mg/L)
V = volume of sample solution
m = mass of adsorbent (g)

Data obtained from the results of lead metal content (Pb) before and after banana skin adsorbent.

3. Result and discussion
This study was preceded by making adsorbent of Kepok banana skin, Ambon banana, and Cavendish banana. The adsorbent of Kepok banana peel is made by drying the banana skin that has been cut into small pieces. After the dried banana peel is smoothed, it is expected that the particle size is expected. The following is a picture of three types of banana peels in figure 1 and banana skin adsorber figure 2.

Determine the amount of concentration of lead metal ions in equilibrium using atomic absorption spectrophotometry (AAS) with the method of lead (Pb) and the wavelength used is 283.3 nm. This wavelength is by SNI 06-6989.8-2004 concerning the determination of lead metal content in waste. This analysis was carried out 2 times. analysis of the concentration or lead level was carried out in the sample before addition and after the addition of the adsorbent. The pump filtering process can be seen in figure 3 while the destruction process for all samples (leachate) can be seen in figure 4.
Before analysis with AAS, the destruction of all samples (leachate) was carried out. Destruction is carried out in acid chambers to prevent the presence of harmful and toxic gases that will be directly exposed/wasted in the environment without filtration. This process uses concentrated nitric acid (HNO₃, 8M), the function of nitric acid is to bind the ions to lead metal present in the sample. Then the samples were analyzed using atomic absorption spectrophotometry (AAS). The results obtained from AAS analysis can be seen in Table 1.

**Table 1. Results of analysis AAS**

| SAMPLE                                      | LEAD METAL CONTENT (Pb) |
|---------------------------------------------|--------------------------|
| Leachate                                    | 0.54 mg/L                |
| Leachate + adsorption of kepok banana skin  | 0.08 mg/L                |
| Leachate + adsorption of cavendish banana skin | 0.16 mg/L              |
| Leachate + adsorbent of ambon banana peel   | 0.27 mg/L                |

The results of AAS in Table 1 obtained levels of lead metal (Pb) in leachate as much as 0.54 mg/L. When added to the adsorbent there is a decrease in lead levels in leachate. Where the decrease can be calculated by looking at the difference in levels of lead metal before and after adding to the adsorption of a banana skin. The effectiveness of the adsorbent in absorbing Pb metal can be seen from its adsorption capacity. The adsorption capacity of the three types of banana peel can be seen in Table 2.

Based on the table it is known that the greatest adsorption capacity is found on the adsorbent of Kepok banana skin. This is by the AAS results which showed a significant decrease in the metal content of Lead in leachate. The greater the capacity of banana peel adsorption, the greater the ability of the adsorbent to bind heavy metals in a solution (Pb metal in leachate) in this study the greatest ability of the Kepok adsorbent was the most effective as an adsorbent. This is in line with previous studies which stated that kapok bananas were used as adsorbents[11],[10] and[5]. The selection of kapok banana as adsorbent an effect is due to the content of the active group in kapok banana [5]. Bananas contain functional groups that act as activated carbon, namely hydroxyl groups, carboxylic groups, and amine groups. This active group can bind heavy metal ions [13].
Based on these results, it can conclude that the greater the adsorption capacity of the banana skin, the greater the ability of the adsorbent to bind heavy metals in a solution (Pb metal) in leachate. This study showed that the kapok banana skin adsorbent had the largest adsorbent capacity of 23 mg/g and could be used as a good alternative adsorbent in leachate compared to the skin of Ambon banana and cavendish.

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