



# The Effect of Banana Peel Biosorbent (*Musa Acuminata*) on Water Clarity, pH, TDS, and DO Levels in Household Wastewater in Bandung

Aulia Fatharani<sup>1</sup>, Cindy Puspita<sup>1</sup>, Ok M Abthal Al-Wafi<sup>1</sup>, Yualinda Durotul Marhamah<sup>1</sup>, Nadiya Syafia Shani<sup>1</sup>, Any Fitriani<sup>1</sup>, Nurfitri Yulianty<sup>1</sup>, Any Aryani<sup>1\*</sup>

<sup>1</sup>Biology, Universitas Pendidikan Indonesia, Indonesia

\*Corresponding E-mail: [any\\_aryani@upi.edu](mailto:any_aryani@upi.edu)

## ABSTRACT

Banana peels consist of nitrogen atoms, sulfur, and organic materials such as carboxylic acids that can function to bind pollutant molecules. The purpose of this research is to use King Banana (*Musa acuminata*) peel as a filtration agent to improve the physical quality of water, including water clarity, pH value, TDS, and Dissolved Oxygen (DO). There are three stages carried out, including preparation of banana peel waste, adjusting the media and filtration time, and data analysis. The preparation process of banana peel waste involves cleaning the banana peel, then drying and mashing it, followed by alkalization using 0.5 N NaOH. Then, variations of the amount of filtration media was made, namely, 60 g, 80 g, and 100 g of banana peels formulated using an additional 30 grams of zeolite with variations in filtration time: 3 hours, 6 hours, and 9 hours. The filtration results obtained using a variation of 100 grams of filtration media with a filtration time of 9 hours are the best media combination, where the results obtained show an increase in water clarity, pH 5.41, and an increase in DO (Dissolved oxygen) of 20.

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## 1. INTRODUCTION

Population growth in Indonesia increased every year. According to the Central Statistics Agency (2023), the population growth rate in Indonesia reached 278.8 million people, showing an increase of 1.1% compared to 2022 (Central Statistics Agency, 2023). Rapid population growth has a significant impact on water use and increased waste production. Besides industry, domestic waste from daily activities is a significant contributor to wastewater. This is also the case with Bandung City, where waste production continues to increase. The waste produced is domestic liquid waste. This liquid waste flows directly into the domestic liquid waste is wastewater from households generated from bathrooms, kitchens, laundry rooms, and toilets. If not treated well, it will harm the environment and cause water pollution.

Several efforts have been made to tackle water pollution problems, one of which is using banana peels as a filtration medium or biosorbent. Several studies used banana peels as adsorbents to reduce water pollution by mixing banana peel powder into contaminated water samples and then stirring and filtering them (Suprabawati & Dwiko, 2016 and Legiso & Heni, 2019). Banana peels were chosen as a filtration medium because banana peel waste has not been widely utilized, so it only becomes waste and a significant source of environmental pollution. Currently, many businesses are developing using bananas as raw materials, but the waste is still considered to have no economic value. Banana peel waste can also be considered for reducing turbidity and heavy metal ion levels in contaminated water (Budiman et al., 2018).

The structure of materials containing cellulose and lignin naturally provides a porous structure and potential to be used as a filtration medium that can adsorb without being burned (Widjanarko, 2006). Banana peel also consists of nitrogen, sulfur, and organic materials. Several efforts have been made to overcome water pollution problems, one of which is by using banana peel as a filtration medium or biosorbent. Several studies have used banana peel as an adsorbent to reduce pollution, such as carboxylic acid. These substances can function to bind pollutant molecules. Therefore, this study was conducted to determine the effect of banana peel as a biosorbent on the physical quality of water, including water clarity, pH value, TDS, and Dissolved Oxygen (DO).

## 2. METHODS

The water samples used in this study were laundry wastewater collected from Cempaka alley. The filtration media used were made from dried banana peels that were blended and sieved using a 60 mesh screen, then alkalized with NaOH for 30 minutes and dried in an oven at 40°C for 24 hours. The variations in filtration media used were 60 g, 80 g, and 100 g, with the addition of 30 grams of zeolite, each of which was placed in a filter bag. After that, the filtration process was carried out with variations in time of 3 hours, 6 hours, and 9 hours on each filtration medium. The parameter of water clarity change was observed, and other parameters were measured using a Water Quality Tester to obtain pH, temperature, and TDS values. The DO parameter was measured using a DO Meter. Data analysis was performed using ANOVA and Kruskal-Wallis tests.

### 3. RESULTS AND DISCUSSION

#### 3.1 Banana Peel Preparation

The banana peels obtained as samples were first cleaned with running water to remove any dirt that may have been carried during sampling. Next, the banana peel was dried using an oven to reduce its water content. Once dry, the banana peel was crushed using a blender to increase its surface area, which would maximize the filtration process because more area could absorb impurities in the artificial waste used, and filtering was carried out using a 60-mesh sieve. This is in line with researchers (Arifiyana & Devianti, 2020) regarding the importance of crushing samples to increase the surface area of biosorbents. The chances of contact with the filtration or adsorption process will also be greater (Imani & Sukwika, 2021). The sample preparation sequence can be seen in Figure 1 below:



Figure 1. a). Drying banana peels, b). Refining banana peel samples, and c). Filter bags filled with banana peels.

Banana peel powder is placed in a filter bag, then used directly as a filtration medium to improve the physical quality of water. In this study, banana peel was used directly without being made into activated carbon. To evaluate the effectiveness of banana peel in its original form, because it already contains various secondary metabolites that are capable of absorbing impurities and even heavy metals. This finding aligns with previous studies, which suggest that banana peel waste can be utilized as a solution to reduce turbidity and heavy metal ions in contaminated water. According to Widjanarko (2006), materials containing cellulose and lignin naturally have a porous structure and have the potential to be used as a filtration medium capable of adsorption without further processing. This is in line with research (Budiman et al., 2018), which shows that Raja banana peels contain various nutrients such as vitamin C, vitamin B, calcium, protein, cellulose, hemicellulose, chlorophyll pigment, fat, arabinose, galactose, rhamnose, and galacturonic acid.

#### 3.2 Analysis of the Effect of the Number of Filtration Media and Filtration Time of Plantain Peel Waste on Clarity Level, pH Value, TDS Value, and DO Value

##### 3.2.1 Water Clarity Level

Water quality that meets health requirements based on Indonesian Minister of Health Regulation No. 32 of 2017, namely clean water quality standards, with requirements that it is tasteless, odorless, with a maximum turbidity level of 25 NTU (Nephelometric Turbidity Units) and a maximum Total Dissolved Solids (TDS) level of 1000 mg/L.

The first observed improvement in the physical quality of water was a change in the level of water clarity. Good water quality is clear (transparent) and not cloudy. For the water

clarification process, variations in the amount of filtration media were used, namely 60 g, 80 g, and 100 g of banana peel, with each filtration process carried out for 3 hours, 6 hours, and 9 hours of circulation.

The results obtained show an increase in water clarity, from its initial brown color to a clearer color. Water quality tests show that of the three treatments carried out, the water quality meets the established quality standards. Based on the tests conducted, it was observed that plantain peel can function as a filtration medium with the ability to adsorb impurities in wastewater, thereby improving water clarity as indicated by the change in water color to a clearer state. As the volume of the filtration medium and filtration time increase, water circulation becomes longer, allowing more impurities in the water to bind to the plantain peel due to longer interaction.



Figure 2. Water Clarity Level 60 grams (left), 80 grams (centre), 100 grams (right)

### 3.2.2 PH Values with Variations in Time and Amount of Filtration Media

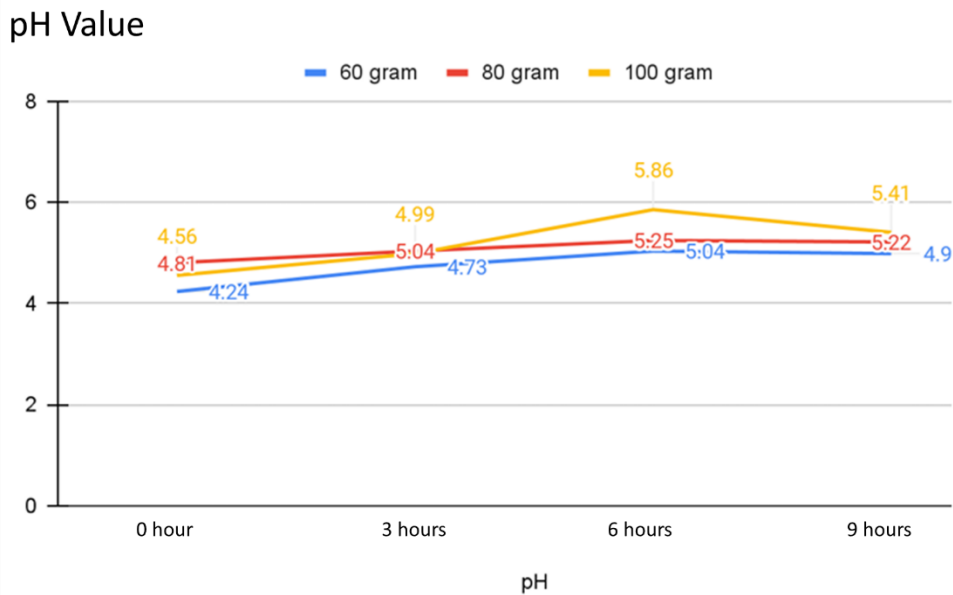


Figure 3. PH values with variations in time and amount of banana peel filtration media

Based on the pH values shown in the graph, it can be seen that this plantain peel filtration medium affects the pH value of household wastewater, which can increase the pH value. With 60 grams of this filtration medium, there was an increase in the initial pH of the water from 4.73 (3 hours of filtration); 5.0 (6 hours of filtration) and 4.99 (6 hours of filtration). Then, with 80 grams of filtration media, there was an increase in the initial pH of the water from 5.04 (3 hours of filtration); 5.25 (6 hours of filtration) and 5.22 (9 hours of filtration). And in the 100-gram filtration media, there was an increase in the initial pH of the water from 4.99 (3-hour

filtration), 5.86 (6-hour filtration), and 5.41 (9-hour filtration). The pH results fluctuated because the biosorbent may capture or release hydrogen ions ( $H^+$ ) during the adsorption process, causing pH fluctuations. Factors such as the biosorbent's ability to absorb certain ions or molecules and the chemical properties of the solution can affect these pH changes.

Based on statistical test results, the pH data is normally distributed and homogeneous. The amount of filtration media used can affect the pH of the water. The results of the ANOVA statistical test show a significance value of  $<0.05$ , which means that there is a significant difference in pH values at 3 hours, 6 hours, and 9 hours. Based on the tests conducted, it can be seen that the safe pH of water ranges from 6 to 9. It can be seen that the pH, which was considered acidic, changed to almost neutral and fell into the safe category. For 100 grams of filtration media, the pH value tended to increase. The more banana peel used, the greater the increase in the pH value of the wastewater, indicating that more impurities are bound to the banana peel. The active components in banana peel can affect the presence of  $H^+$  ions in water, thereby affecting the pH value. This is in line with research (Legiso; 2019) which reveals that activated carbon from plantain peel is effective in increasing the pH value. Similarly, research (Suharlina & Umroh, 2016) states that there is an increase in pH value in particles treated with banana peel powder.

### 3.2.3 TDS Values with Variations in Time and Amount of Filtration Media

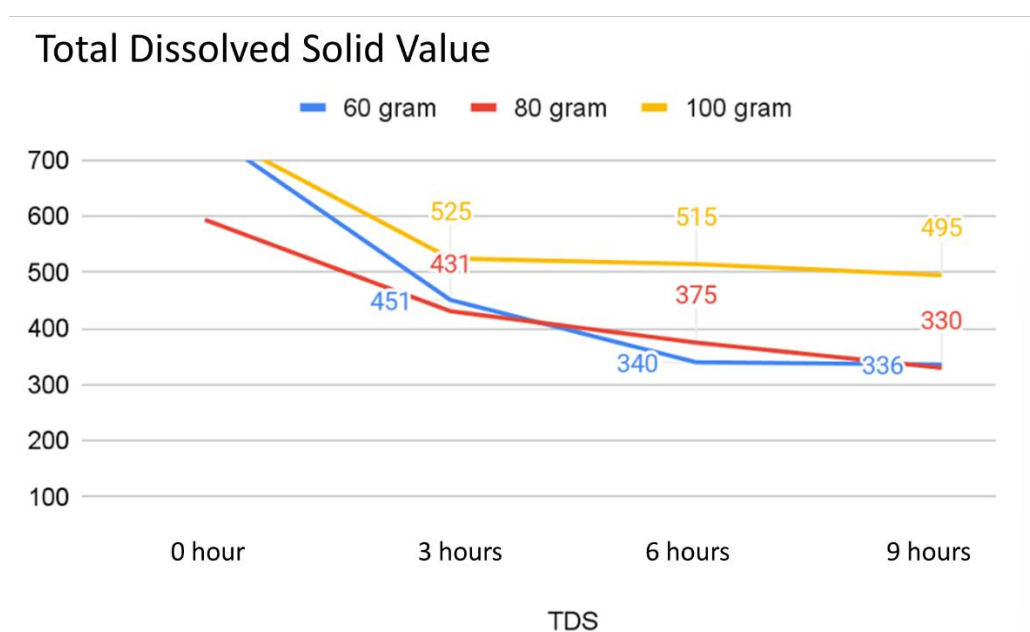


Figure 4. TDS value with variations in time and amount of banana peel filtration media

Based on the results of statistical testing, the TDS data was not normally distributed at filtration times of 3 hours and 6 hours. The length of filtration time can affect the TDS of water. The results of the Kruskal-Wallis test showed that there was no significant difference in TDS values with a result of 0.057 and a significance value  $> 0.05$ . TDS is the amount of dissolved solids in water. The TDS value indicates the content of organic and inorganic substances, minerals, and dissolved materials in the water (Ariani & Nurhasanah, 2020). Furthermore, (Hafni, 2012) states that water turbidity can be caused by the presence of inorganic and organic substances contained in the water.

Based on the TDS values shown in the graph, it can be seen that this plantain peel filtration media affects the TDS value of household wastewater. For TDS 60 g with variations in filtration

time, the initial TDS value of 753 mg/L became 451 mg/L (3-hour filtration), 340 mg/L (6-hour filtration), and finally 336 mg/L (9-hour filtration). For TDS 80 g with filtration time variations, the initial TDS value of 594 mg/L became 431 mg/L (3 hours of filtration), 375 mg/L (6 hours of filtration), and finally 330 (9 hours of filtration). And for a TDS value of 100 g For TDS 80 g with filtration time variations, the initial TDS value of 756 mg/L became 525 mg/L (3-hour filtration), 515 mg/L (6-hour filtration), and finally 495 (9-hour filtration). For all TDS values, whether by weight in grams or with different variations, there was a decrease in TDS values as filtration time increased.

This shows that banana peel has the ability to bind solid substances dissolved in wastewater, thereby reducing their concentration. The longer the circulation, the greater the intensity of interaction. This is in line with what was stated (Hanifah & Hadisoebroto, 2020) that in general, banana peel consists of minerals, vitamins, proteins, carbohydrates, and fats. One of the active substances that plays a role in the coagulation process is protein. This causes the wastewater to become clearer and the TDS to decrease.

### 3.2.4 Perubahan Nilai DO dengan Variasi Waktu dan Jumlah Media Filtrasi

#### Dissolved Oxygen Value

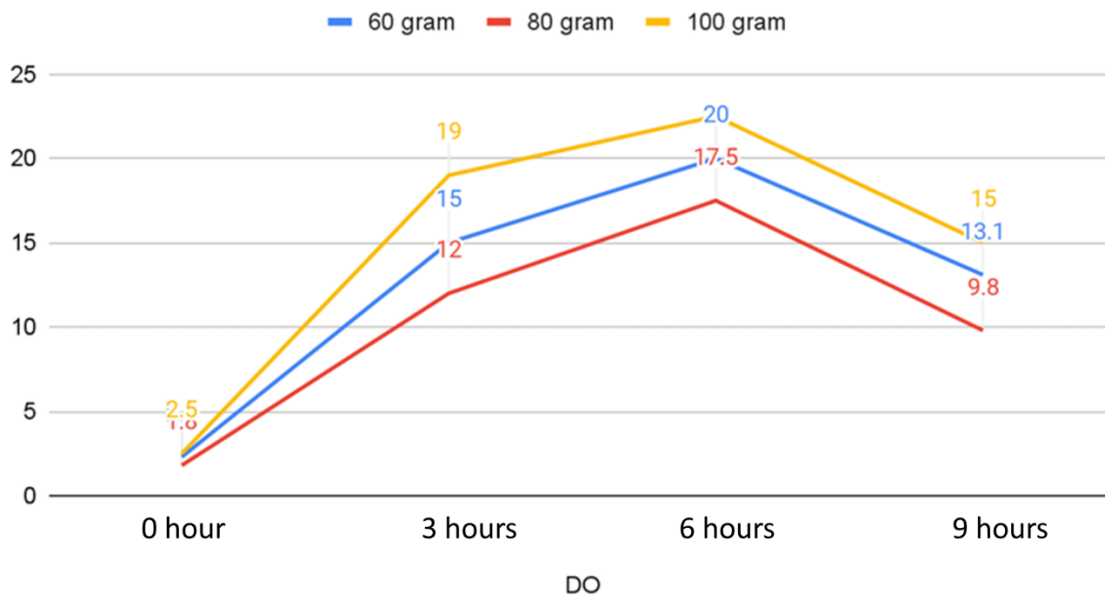


Figure 5. DO value with variations in time and amount of banana peel filtration media

Based on the results of statistical testing, the Dissolved Oxygen (DO) data is normally distributed. The amount of filtration media used can affect Dissolved Oxygen (DO). The results of the ANOVA test show that the significance value is  $< 0.05$ , which means that there is a significant difference in Dissolved Oxygen (DO) values at 3 hours, 6 hours, and 9 hours. The graph shows that the DO value increased in the 3-hour and 6-hour treatments. However, in the 9-hour treatment, the DO value decreased. This could be due to the fact that the longer the filtration time, the greater the fluctuation in DO. This is in line with Sisnayati's (2021) research, which found that the longer the filtration time, the greater the fluctuation in DO, meaning that the DO value in the filtration process has no correlation. This is because the longer the filtration time, the more oxygen is introduced into the water sample filter container, resulting in a higher COD concentration being deposited.

Dissolved oxygen is the concentration of oxygen dissolved in water. There are significant differences between the three treatments. The higher the DO value, the lower the level of water pollution or the lower the COD and BOD values. High BOD and COD values have an impact on the decrease in dissolved oxygen because microorganisms in the water will consume dissolved oxygen, indicating that the water is polluted.

#### 4. CONCLUSION

Based on the research conducted, it can be concluded that Raja banana peel powder, without being turned into activated charcoal or chemically and physically activated, still has effectiveness in improving water quality, including affecting water clarity levels and significantly increasing pH values from acidic to neutral, namely in the range of 4.24-5.86. A filtration medium of 100 grams with a filtration time of 9 hours is the best combination of media. Simplified banana peel powder formulated with zeolite can also affect the TDS value in water bodies, although the percentage decrease in TDS value is not significant because banana peel itself contains various minerals that can dissolve in water and increase the TDS concentration of the water. For Dissolved Oxygen (DO), there is a significant difference. Water quality is measured based on dissolved oxygen (DO); the higher the dissolved oxygen (DO) content, the better the water quality.

#### 5. ACKNOWLEDGMENT

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#### 6. AUTHORS' NOTE

The authors declare that there is no conflict of interest regarding the publication of this article. Authors confirmed that the paper was free of plagiarism.

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