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BIO-ADSORPTION PROCESS USING CARICA SEED TO REDUCE WATER TURBIDITY FROM LINGGI RIVER

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ABSTRACT
This study examined natural adsorbent (papaya seed) in reducing turbidity from Linggi River. The natural adsorbent, papaya (carica) seed was grinded in powder form. Adsorption test was conducted to test the turbidity of the water sample through a jar test. The optimum dosage of papaya seed powder was identified in order to obtain the optimum turbidity removal. The effectiveness of papaya seed on the adsorption process was compared with chemical alum which was an aluminium sulfate solution. 6L of water samples from Linggi River were collected in December 2019 per batch. There were three batches in total. Interval dosage of papaya seed powder was 40 mg/L which started from 40 mg/L, 80 mg/L, 120 mg/L, 160 mg/L and 200 mg/L. Aluminium sulfate was added 10 mg/L in the first beaker jar test to be compared with papaya seed in reducing the turbidity level. The average turbidity of water samples from Linggi River was 81.7 NTU before the test. The lowest turbidity value was 3.95 NTU with the optimum dosage of 80 mg/L of papaya seed powder. Based on the results obtained, papaya seeds have the ability to control the turbidity from river intake.

Keywords:
Adsorption test, jar test, Linggi River, papaya seed, turbidity

INTRODUCTION

Rivers are usually considered as freshwater which flows towards the ocean, sea or lake. Moving water dilutes and decomposes pollutants more rapidly compared to still water. Municipal and industrial sewage couples with anthropic activities (Sekharan et al., 2022) causes more diluted solids and results to turbid water on river water.

Water turbidity is measured using the nephelometry which is the relative measurement of light scattering through a restricted range of angles to the incident light beam. Turbidity measured by different turbidimeters would be producing different numerical NTU values. Turbidity can be determined as the cloudiness or haziness of fluid which is caused by the huge number of particles that could not be seen by human eyes. If there are very tiny particles (suspended solid) in the water, it would sink very slowly or not at all if the particles are colloidal. These particles would cause the water to appear turbid.

According to the Department of Environment (2019), Linggi River was classified under Class II for river water classification and sub classes for suspended solids it shows under Class III. Based on Class II, it requires conventional treatment as a water supply (Razak et al., 2021). The turbidity of water sample from Linggi River is tested which is 111 NTU, considered as high turbidity water. The water does not fulfill the water parameter from WHO which is 5 NTU for drinking water (Rahmanian et al., 2015). Thus, it needs to be treated to reduce its turbidity by coagulation. Solids that cause the turbidity condition of water can be reduced using the suitable treatment process. The Absorption process became the chosen process in removing the turbidity.

This adsorption process has been identified as a physicochemical method in reducing the turbidity. It effectively removes the colloidal and suspended solids by the usage of the coagulants. Coagulants can be based inorganic and organic. Several inorganic coagulants or chemical based substances such as alum, polyaluminium chloride and ferrous sulfate can cause several harmful effects towards human health. Aluminium can be overused for efficient coagulation but the overuse of

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aluminium salt increases the alum concentration and cause turbidity. Excess consumtion of aluminium causes Alzheimer's disease (Chandran et al., 2015). Other than that, these inorganic coagulants are quite costly in order to treat the chemical sludge, which is the end product of agglomeration formation. Thus, several studies have been conducted to use natural coagulants which are cost effective and nontoxic to water supply (Kusuma et al., 2022).

Papaya seed or known as Carica Seed can be one of the natural coagulants in bio-adsorption process. Papaya seeds are a rich source of protein. The presence of the positively charged proteins in papaya seeds work as a coagulant because it can bind with the negatively charged particle which is silt, clay, bacteria and toxins. It allows the solid to settle down at the bottom of the water after treatment. It can be used in order to get a clear water result. It is proven that the usage of papaya seeds powder is an efficient natural coagulant and reduces the dosage of alum that brings side effects to human health (Chandran et al., 2015).

In this study, bioadsorbents using the Carica seed in reducing the turbidity from Linggi River were tested. To achieve this research, several objectives were conducted. The objectives were (1) to identify the physical characteristic which is the turbidity of water sample from Linggi River, (2) to obtain the optimum dosage of papaya seeds powder on adsorption process, (3) to determine the effectiveness of papaya seeds as natural coagulants compared to inorganic coagulants, chemical alum.

METHODOLOGY

Sampling Location

6 liters of water samples were collected from the Linggi River in December 2019 per batch. Three batch of water collection in total. Water sampling were collected by gap of one week per batch. Batch 1 was collected on 6 December 2019, batch 2 collected by 13th December 2019 and batch 3 collected by 20th December 2019. A grab sampling was chosen as collecting the water sample. Sampling location as shown in Figure 1. The river flows from Pantai to Ampangan, Seremban, Rasah, Mambau, Rantau, Linggi and ends at Kuala Linggi, Melaka. The water sample was collected from the river that pass through Rasah, Seremban.

Figure 1: Map of sampling location (Linggi River); sampling location as sub-picture taken in December 2019

Preparation of Carica (Papaya) Seed

A papaya fruit was sliced open using a clean knife. Distilled water was used to wash the papaya seeds. The seeds were dried under the sun for at least 7 days before crushing them into powder. Home grinder was used to crush the seeds into fine powder. The fine powder was collected into an air-tight container for experiment later. Papaya seeds were grinded as powdery condition as shown in Figure 2.

Figure 2: Papaya seed powder

Preparation of Alum Stock Solution

10 grams of aluminium sulfate was added into 1000 ml of distilled water per batch. Each 1 ml of this stock was equal to 10 mg/L when added to 1000 ml to be tested.

Experimental Setup

This experiment was applied by jar test as shown in Figure 3 to conduct the adsorption process treatment. First, six of 1 Litre beakers were prepared with water samples from Linggi River respectively. The first beaker was added 10 mg/L of stock solution whereas another five beakers were added different dosage of papaya seed powder which were 40 mg/L, 80 mg/L, 120 mg/L, 160 mg/L and 200 mg/L. Then, six beakers were placed in jar test machine and started the mixing process simultaneously. The stirrers were turned on after the dosing process. The mixing process was at 50 rpm for 30 seconds in the beginning of the experiment. The mixing speed was adjusted to 110 rpm for 1 minute for the rapid mix purpose. The mixing speed was adjusted into 50 rpm again continuous for 30 minutes. The settling process was allowed for 1.5 hours. The experiment was repeated for another two times from step 1 to 6 by using the water sample. The final turbidity was analyzed and recorded. Sample collection and testing procedures were performed according to the Standard Method for Water and Wastewater Analysis (APHA, 2017).

Figure 3: Jar test

RESULTS AND DISCUSSION

Physical Characteristics of Linggi River

Physical characteristics of Linggi River water as shown in Table 1. Average turbidity, pH and temperature were 81.7 NTU, pH 7.23 and 25.57 ºC respectively. Turbidity readings show high value due to the rainy season in Seremban, Negeri Sembilan during December 2019 as shown in Figure 4. Average monthly rainfall in Seremban (Negeri Sembilan) in Millimeter from the World-Wide Travel Organization, Amsterdam in December shows more than 150mm. This rainfall distribution shows the reason of quite high turbidity concentration of the river, pH value in neutral condition and it does not create a harmful effect on Linggi River. Since it is quite rainy in December, the temperature was 25.57 ºC which is quite cold.

Table 1: Characteristics of Linggi River

Parameters	Turbidity (NTU)	pH	Temperature (ºC)
Value	81.7	7.23	25.57

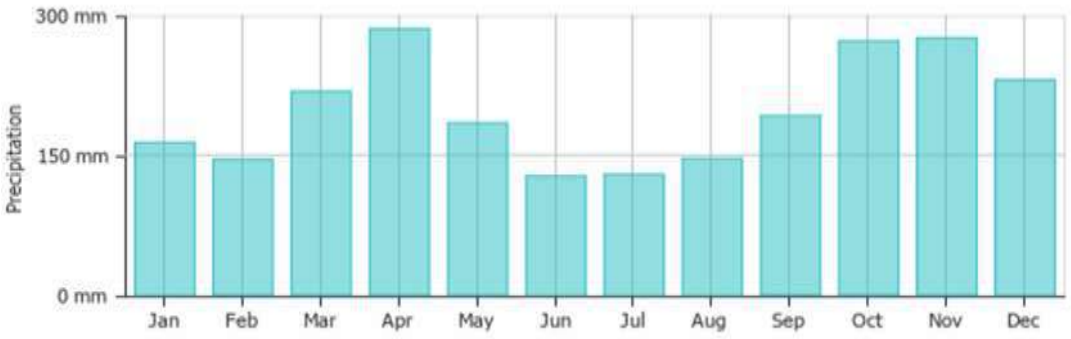

Figure 4: Average monthly rainfall in Seremban (Negeri Sembilan) in Millimeter from the World-Wide Travel Organization, Amsterdam in 2019

Optimum Dosage of Papaya Seeds Powder on Adsorption Process

The optimum dosages of Papaya Seeds were checked based on three batch of experiments shown in Figure 5. Batch 1 which is on 6th December 2019, batch 2 on 13th December 2019 and batch 3 on 20th December 2019. The optimum dosage based on batch 1 shown in Figure 5 was at 80 mg/l and turbidity reading shows 10.4 NTU. Followed by batch 2, the optimum dosage was 80 mg/l as well and turbidity reading shows 6.28 NTU and the optimum dosage for batch 3 was 80 mg/l by reading of 3.95 NTU. These results could be concluded that the overdose of papaya seed powder contributed to the turbidity in water. Thus, the optimum dosage of papaya seed powder was 80 mg/L from the experiment. According to Chandran et al., (2015), the presence of the positively charged proteins in papaya seeds work as a coagulant because it can bind with the negatively charged particle which is silt, clay, bacteria and toxins. It allows the settling down of solid at the bottom of the water after treatment.

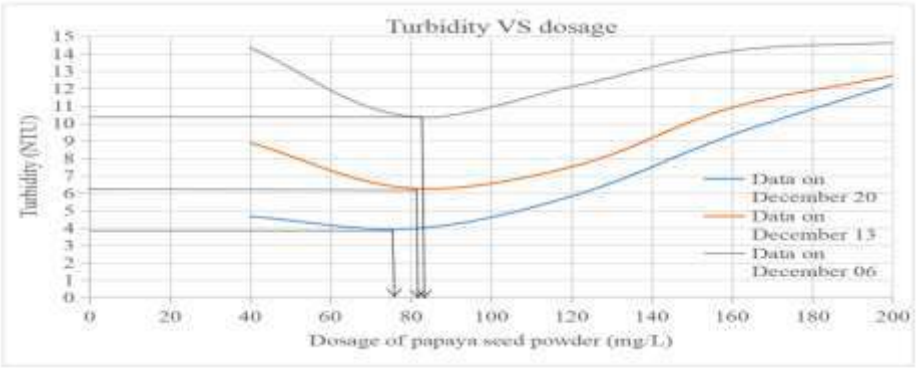

Figure 5: Graph of turbidity against dosage of papaya seed powder

Comparison on Application of Chemical Alum and Papaya Seed Powder

Chemical alum which was an aluminium sulfate solution applied in the first beaker in adsorption test. The concentration of alum was 10 mg/L. The turbidity of the water was measured after the adsorption test. The result showed turbidity was 1.47 NTU. The lowest turbidity reduction using papaya seed as natural coagulant was 3.95 NTU. The safe limits of turbidity from the World Health Organization (WHO) is within 5 NTU (Rahmanian et al., 2015). The application of chemical alum and papaya seed powder were lower than the required limits which was 5 NTU. However, application of aluminium sulfate would be affecting the human body. The dosage of aluminium sulfate was consumed by humans little by little during drinking of water. It may cause Alzheimer's disease in the human body (Chandran et al., 2015) Thus, although the turbidity reduced by using aluminium sulfate was more effective, it may be replaced by the application of papaya seed powder in order to reduce the potential of experiencing Alzheimer disease.

CONCLUSION

Parameters such as pH, temperature and dissolved oxygen were measured as physical properties of Linggi River. Turbidity, pH and temperature were 81.7 NTU, pH 7.23 and 25.57 ºC respectively. The interval dosage of papaya seed powder was 40 mg/L. The optimum dosage of papaya seed powder was 80 mg/L. Three sets of data were plotted in a graph of turbidity against dosage. The lowest point of the three curves were around 80 mg/L. The lowest turbidity value was 4.66 NTU after the treatment. Chemical alum which was an aluminium sulfate solution was used in the first beaker to compare with others using papaya seed powder at different dosage. 10 mg/L of chemical alum was added to the water sample. The lowest turbidity was 1.47 NTU with the applied of 10 mg/L chemical alum solution whereas the optimum turbidity was 4.66 NTU with 80 mg/L of papaya seed powder. The chemical alum and papaya seed powder were effective in reducing the turbidity of water samples. Although the chemical alum had a higher efficiency than papaya seed powder, it would cause Alzheimer disease.

AUTHORS BIOGRAPHY

Khairunisah Kamaruzaman is a lecturer in the Civil Engineering & Construction Department of Infrastructure University Kuala Lumpur. She received her Master of Science in Environmental Engineering from Universiti Teknologi Mara in 2014. Her area of expertise is Environmental Engineering with a focus on Water & Wastewater Treatment. Her research project for bachelor degree focusing on Phytotoxicity of Seed Germination and accomplished research project for master degree in Geopolymer study.

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