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# The Usage of Banana Peels and Soybean Hull for the Treatment of Lake Water: Turbidity and Total Suspended Solids

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**Abstract:** Lake water get contaminate due to the growth of population and modernization which causing problems like sewage disposal has a high-volume and low-strength wastewater that can be reused for many purposes after being treated. It is crucial for wastewater to go through wastewater treatment to improves the quality of water where one of the processes involved is coagulation yet using conventional coagulant leaves excess heavy metal in the water causes in the absence of green chemistry. Chemical coagulants may have an adverse effect on the consumer and the environment such as aluminum build up in the environment, as well as have a harmful influence on the human body, resulting in Alzheimer's disease. The use of natural coagulants can be a secure replacement for chemical coagulants. Therefore, this study was conducted to reduce the usage of chemicals in the coagulation process by using natural coagulant of banana peels and soybean hulls. The main aim of this study is to investigate the effect of natural coagulant for wastewater treatment of lake water. Banana peels and soybean hulls were the main materials in making a plant-based coagulant by drying, grinding, and sieving. Jar test was carried out to investigate the effectiveness of natural coagulant by determining their turbidity and total suspended solids. It was found that banana peels perform effectively at a dosage of 400mg/L with turbidity removal achieved is almost 50%. On the other hand, soybean hulls work effectively at a dosage of 600mg/L with turbidity removal achieved is 54%. Based on the result, it is shown that using banana peels as a natural coagulant has effectively reduced the turbidity and total suspended solids of lake water with the optimum number of dosages of 600mg/L.

**Keywords**: Wastewater, natural coagulation, plant-based, banana peels, soybean hulls

## 1. Introduction

The water cycle on Earth ensures a constant supply of water for all living organisms. Freshwater is heavily used and diverted by humans for important economic, agricultural, and countless other livelihood activities, but unfortunately that puts tense pressure on the natural water bodies. [1]. As the population grows, more water will be consumed, resulting in a higher volume of wastewater [2]. The deterioration of water resources places more responsibility and pressure on streams and river bodies to purify themselves. Pathogens, organic materials, and heavy metals are only some of the contaminants that can contaminate wastewater from many sources [3]. Their concentrations occasionally surpass the allowable discharge levels, posing serious risks. As a result, significant financial investments must be made to successfully overcome wastewater problems.

Wastewater comes from a variety of sources that contribute to water pollution such as domestic and industrial where it consists of clays, oils, human waste, food scraps, heavy metal, and others. Lake water gets contaminated due to the

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growth of population and modernization which is causing problems like sewage disposal [4]. It is a high-volume and low-strength wastewater that can be reused for many purposes after being treated. Hence, coagulation is one of the ways used to treat wastewater by using coagulants. There are two types of coagulants which are conventional chemical coagulants and natural coagulants.

Coagulation has been used in wastewater treatment since the beginning, with the main goal of removing colloidal impurities and thus removing turbidity from the water. Coagulant is a chemical that is added to water to remove the forces that stabilize colloidal particles, allowing the particles to float in the water. When the coagulant is added to the water, the individual colloids must aggregate and grow larger for the impurities to settle to the bottom of the beaker and be separated from the water suspension. Coagulants made of aluminum and iron are widely used in most industries. However, when aluminum is used as a coagulant in wastewater treatment, it can have several negative effects on human health including intestinal constipation, memory loss, convulsions, abdominal colic, energy loss, and learning difficulties [5].

Coagulant is used to reduce turbidity including reductions in sludge production and balance out the pH of treated water [6]. In addition, the usage of chemical coagulants is huge in wastewater treatment industries as it shows an effective result in treating wastewater. However, using conventional coagulant leaves excess heavy metal in the water causing the absence of green chemistry [7]. Furthermore, due to the high prices of imported chemicals and the scarcity of chemical coagulants, the usage of aluminum sulphate or also known as alum salts is unsuitable [8]. The use of a chemical coagulant such as alum may produce disposal issues such as aluminum build up in the environment, as well as have a harmful influence on the human body, resulting in Alzheimer's disease [9]. It also poses a concern to human health and the environment, as it is frequently the source of serious health problems such as cancer and organ damage [10].

Hence, natural, or plant-based coagulants are used to treat wastewater to reduce the negative impact of using chemical coagulants by minimizing the use of the hazardous compound. This is because plant-based coagulant is nonhazardous or harmless to human and aquatic life. It is also a biodegradable product and made of renewable resources that are easy to find [11]. Therefore, to reduce the risk of chemical exposure to humans and the environment, aluminum sulphate chemicals are reduced by substituting the chemical coagulant with a natural coagulant.

According to previous research, employing plant-based material as a natural coagulant to treat wastewater has proven to be more effective than using a chemical coagulant. The plants were effective to remove turbidity and color from the water sample using 40-120 mg/L of plant-based coagulant [11]. Thus, this study is conducted to analyze the effectiveness of banana peel coagulant (BPC) and soybean hull coagulant (SHC) to remove turbidity and total suspended solid of lake water samples based on the number of dosages of these plants.

## 2. Materials

The main ingredients of this study are banana peel and soybean hull. The sample of natural coagulant preparations consisted of drying at 105°C in the oven for 7 hours, grinding the dried sample using domestic blender turned into powder and sieving into the powder through a 500 μm sieve to have fixed powder size. The sample of water used was taken from a lake near Universiti Tun Hussein Onn, Pagoh (UTHM).

## 3. Methodology

A conventional jar test apparatus was used to coagulate, flocculate, and make sedimentation of surface water sample using natural plant-based coagulants namely soybean hull coagulant (SHC) and banana peel coagulant (BPC). Six beakers of 500ml of wastewater sample were prepared as a control and the initial turbidity and color were measured. Three beakers were for experiment using SHC and the other three for BPC.

0.1 g of the SHC that passed through the 500 pm sieve was added to one beaker of 500 ml of distilled water forming a suspension. A magnetic stirrer was used to stir the mixture. The mixture was rapidly stirred at 140 rpm after the addition of the coagulant for 3 minutes. Then, the stirring continued slowly at a speed of 20rpm for 1 hour and then it was left to settle for 30 minutes to allow the flocculation process. The flocs then underwent a sedimentation process for 30 minutes. After that, it was filtered to obtain 1wt.% soybean hull and the sample was taken for turbidity and total suspended solid analysis. The natural coagulant amount used in this experiment for both soybean hull and banana peels were 0.1g, 0.2g and 0.3g respectively.

The initial and final values of turbidity and total suspended solid of lake water sample were analyzed before and after the treatment process been conducted. Figure 1 shows the setup of jar test experiment for this study.

**Fig. 1 - Jar test experiment setup**

The analysis result of turbidity of lake water was measured to determine the cloudiness of each sample after using the BPC and SHC. The value of turbidity was measured by a turbidity meter with a nephelometric turbidity unit (NTU). Meanwhile, for determination of the total suspended solid in sample, the sample was filtered through a filter paper with 11 qm diameter pore size. The residue on the filter was dried at 110°C in the oven on evaporating dish. After drying in the oven, the filter paper was cooled to room temperature in a desiccator to avoid moisture absorption by filter paper. The final weight of the filter paper was measured using the analytical balance. The increase in the weight of the filter represented the total suspended solid. The value of total suspended solids in water was calculated using equation 1 below:

$$\left[\frac{(W_f - W_i)\times 1000\ mg}{Volume\ of\ Sample,mL}\right] \times\ 1000\ mL/L = Value\ of\ TSS,\ mg/L \qquad (1)$$

Where:

- Wi = Initial weight
- Wf = Final weight

## 4. Result and Discussion

Table 1 shows the turbidity of samples before and after the treatment. Based on Table 1, the blank sample has a turbidity of 0.22 NTU while the lake water sample shows turbidity of 4.90 which shows that it has a higher number of suspended solids than the blank sample. The water sample also appears slightly cloudy. After the samples are treated, the final turbidity of BPC is displayed in the values of 2.74 NTU, 2.46 NTU, and 2.65 NTU. The results displayed show the level of turbidity of the sample had decreased after being treated. Meanwhile, the SHC has final turbidity of 5.44 NTU, 4.47 NTU, and 2.25 NTU. The pattern of SHC results revealed that the larger the amount of dose used, the lower the value of turbidity of the lake water sample.

**Table 1 - Turbidity of samples**

| Weight of coagulant | Initial, NTU | Banana peel coagulant (BPC), NTU | Soybean hull coagulant (SHC), NTU |
|---|---|---|---|
| Blank | 0.22 | - | - |
| 200 mg/L | 4.90 | 2.74 | 5.44 |
| 400 mg/L | 4.90 | 2.46 | 4.47 |
| 600 mg/L | 4.90 | 2.65 | 2.25 |

Figure 2 shows the percentage of turbidity reduction versus amount of dosage for each banana peels coagulant, BPC, and soybean hulls coagulant, SHC. For BPC, each percentage of turbidity reduction for 200 mg/L, 400 mg/l, and 600 mg/L are 44%, 50%, and 46% respectively. Meanwhile, for SHC, each percentage of turbidity reduction for 200 mg/L, 400 mg/l, and 600 mg/L are -11%, 9%, and 54% respectively. When the number of dosages used is low, the removal of solid from a sample is low or the coagulation process becomes less effective.

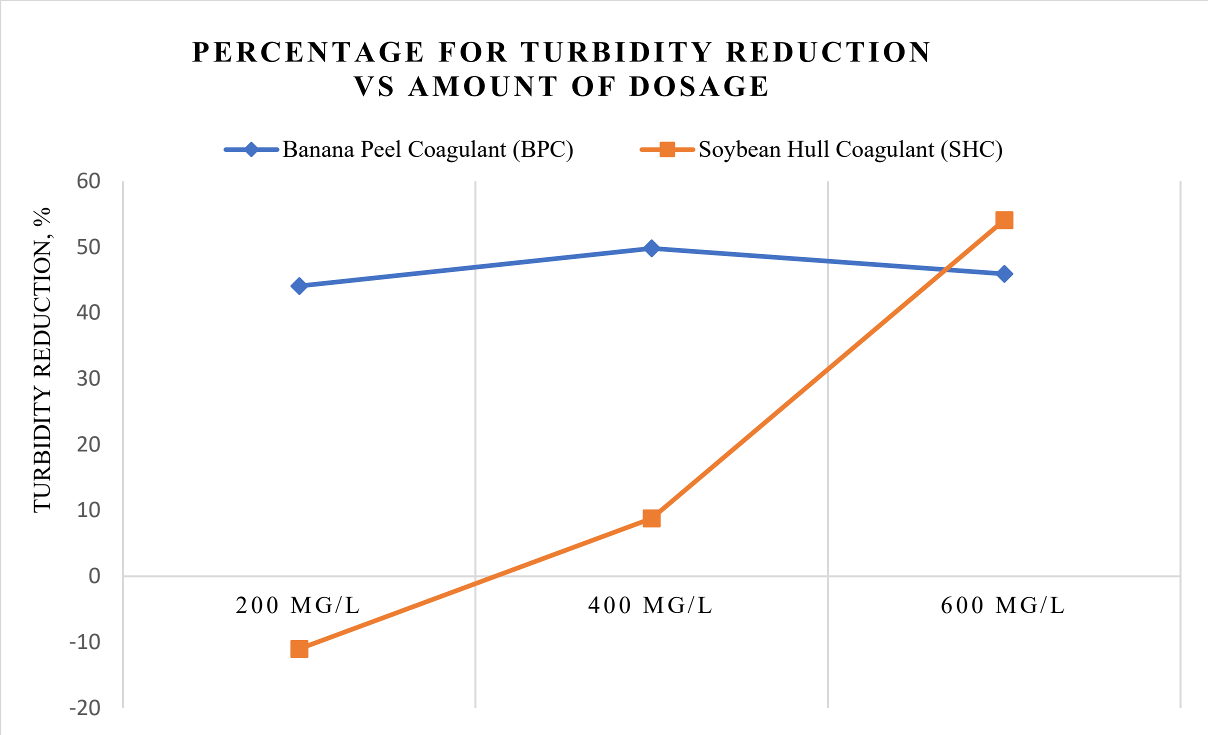


**Fig. 2 - Turbidity reduction of water sample using BPC and SHC**

Based on Figure 2, the BPC is perceived to perform effectively at a dosage of 400mg/L because the turbidity removal achieved is almost 50%. On the other hand, the SHC is expected to work effectively at a dosage of 600mg/L because the turbidity removal achieved is greater than 54%. For treatment using BPC, the water appeared to be cleaner, and more flocs were successfully formed in 400 mg/L compared to 200 mg/L and 600 mg/L. This indicated that the dosage of 400 mg/L is the most effective amount to treat collected lake water [12]. It can be deduced that the coagulant dosage has a significant influence on the coagulation process [6]. In short, it could interpret that a larger coagulant dosage will directly add to the natural coagulant's effectiveness in lowering lake water turbidity [11]. Meanwhile, for treatment using SHC, there is an increase in turbidity in 200 mg/L compared to initial turbidity value. This is because, concentration of coagulant is higher than the optimum value causing interruption in the reaction between the coagulant and particles in the wastewater. This reduction can be hypothesized that overdosing contributes to destabilization of colloidal particles and charge reversal [10].

In other hand, Table 2 shows the initial and final values of total suspended solids of samples before and after the treatment process of coagulation. Table 2 shows the sample have the initial value of total suspended solids of 50 mg/L before the addition of coagulant. After being treated, the final value of BPC for 0.1g is 50 mg/L and 10 mg/L for 400mg/L and 600mg/L. The result for 200mg/L of BPC shows an unchanging value of total suspended solids. However, for the other two samples, the values of total suspended solids decreased. Next, the result displayed for SHC is 40 mg/L, 30 mg/L, and 20 mg/L. According to the findings, the level of solids in lake water samples decreased as the amount of SHC increased.

**Table 2 - Total suspended solids of samples**

| Weight of coagulant | Initial, mg/L | Banana peel coagulant (BPC), mg/L | Soybean hull coagulant (SHC), mg/L |
|---|---|---|---|
| 200 mg/L | 50 | 50 | 40 |
| 400 mg/L | 50 | 10 | 30 |
| 600 mg/L | 50 | 10 | 30 |

From Figure 3, the total suspended solid for treatment using BPC after treatment is the same as the total suspended solid value of water sample before treatment. This means that the amount of coagulant used is ineffective and unable to coagulate particles in water sample. The other amount of dosage used are 400mg/L and 600mg/L. By using these amounts, the total suspended solid calculated after treating drops are 50mg/L to 10mg/L respectively. This indicated that the amount of dosage for 400 mg/L is an optimum value [12]. However, adding another 200mg/L of coagulant to the same volume of water sample does not affect the coagulation performance. The reason is because the amount does not exceed the limit of optimum value of coagulant needed to treat the wastewater. This could be proved that in 600 mg/L, the total suspended solid has the same value after treating. Hence, it could be said that the amount of dosage for 400 mg/L and 600 mg/L are the most efficient amount for the wastewater treatment of the water sample that been collected.

Figure 3 shows the percentage of total suspended solid, TSS reduction versus amount of dosage for each banana peels coagulant, BPC, and soybean hulls coagulant, SHC. For BPC, each percentage of TSS reduction for 200 mg/L, 400 mg/l, and 600 mg/L are 0%, 80%, and 80% respectively. Meanwhile, for SHC, each percentage of TSS reduction for 200 mg/L, 400 mg/l, and 600 mg/L are 25%, 67%, and 67% respectively.

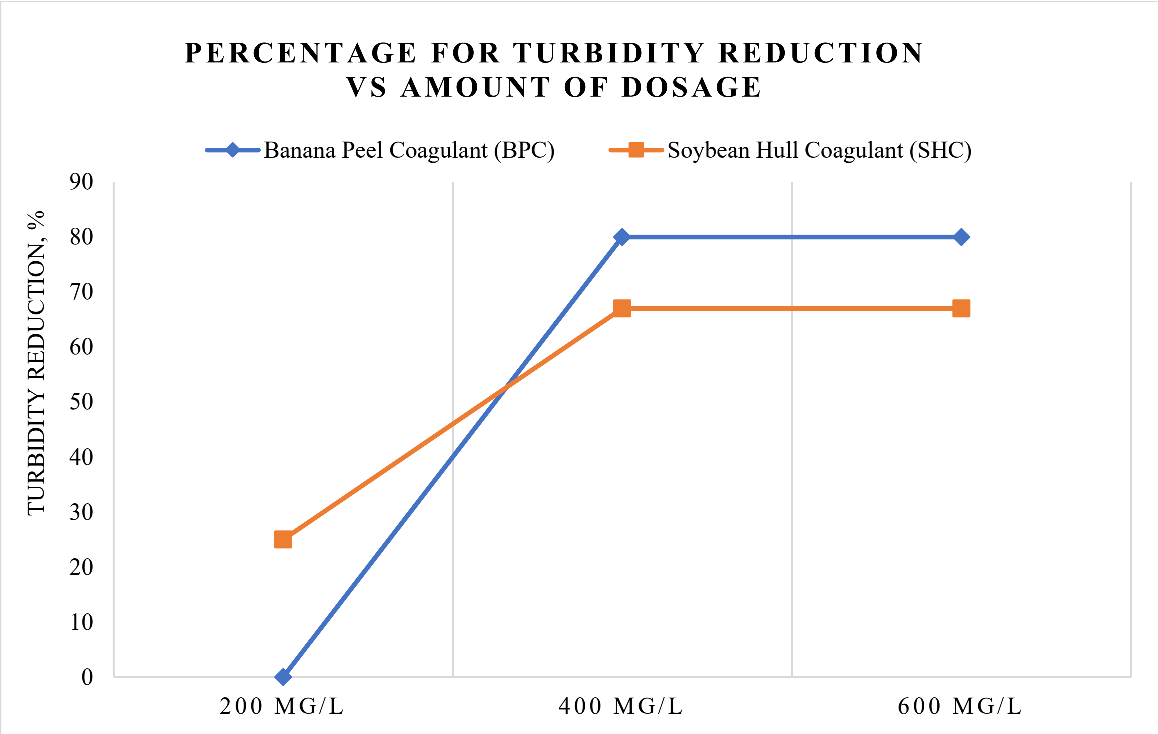


**Fig 3 - Total suspended solid reduction % of water sample using BPC and SHC**

Based on Figure 3, the total suspended solid reduction in the treatment using soybean hull for 200 mg/L is 25% whereas 400 mg/L and 600 mg/L have achieved reduction of 67%. In this experiment, the total suspended solid decreases as the amount of dosage of coagulant increases. Even though the TSS reduction of 400 mg/L and 600 mg/L is the same, the amount of dosage 600 mg/L is most effective. This is because the amount of dosage in 600 mg/L has achieved a higher turbidity reduction percentage compared to 400 mg/L. This could be proved in Figure 2**.** Hence, it is safe to say that the amount of coagulant in 600 mg/L is more efficient in treating wastewater sample compared to 200 mg/L and 400 mg/L dosage of natural coagulant. So, the optimum amount of dosage in this experiment is 600mg/L [6]. Based on the finding, it shows that banana peels as natural coagulants can replace the usages of conventional chemical coagulants in treating lake water. It is also cost-effective and biodegradable as banana peels come from food waste.

## 5. Conclusion

In a nutshell, it can be concluded that the best natural coagulant is banana peels as it shows an effective performance of removing solids in lake water samples than soybean hulls. BPC mostly reduced both values of turbidity and total suspended solids of lake water samples than SHC. Each plant utilized an optimum number of dosages of 600mg/L to reduce the solids from the lake water sample effectively. This study looks ahead to contribute and raise awareness of green chemistry in wastewater treatment technology by substituting the conventional chemical coagulant with natural coagulant where it is safer and cheaper.

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