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Research paper

The Effectiveness of *Psophocarpus Tetragonolobus*'s Seed as Turbidity Removal

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Abstract

High turbidity in water not only will reduce the quality of water itself but it can give impact to the ecosystem as well. In water treatment, coagulation and flocculation are the process involved in removing turbidity. Chemical coagulant such as aluminium sulfate (Alum) and ferric chloride are effective way and widely used in order to remove the turbidity in water. However, these chemical coagulants have a side effect in spite of the effectiveness in turbidity removal, the usage of alum and other chemical coagulants bring concerns due to its impact to the environment, human health and economy. Therefore, natural coagulant is another alternative for turbidity removal in water treatment. Natural coagulant is a plant-based coagulant which can be used to replace chemical coagulants. These coagulants are generally cheaper and safer than chemical counterparts. This research is conducted to compare the effectiveness of natural based coagulant made from *Psophocarpus tetragonolobus* and chemical coagulant in improving the quality of raw water. Findings from this study showed *P. tetragonolobus* can remove turbidity up to 60 percent with 40 ml, 1% solution. Therefore, *P. tetragonolobus* can be considered as a potential resource for natural coagulant.

Keywords: *natural coagulant, water treatment, turbidity*

1. Introduction

The most common method to eliminate impurities from water is by coagulation. The application of coagulation process is to remove turbidity and organic matter in water. In coagulation, a coagulant with positive charge particle is added causing double layer to compress and eventually neutralize the electrostatic surface potential of the particles (Region, 2005). When the coagulant made contact, the particles will stick together to form floc. Flocculation process is essential to produce larger flocs. These flocs are then able to settle rapidly by gravity. There are two commonly used chemical coagulants which are aluminium sulfate and ferric chloride. Coagulation and flocculation process can be tested in a laboratory by using jar test.

Chemical treatment techniques are effective in turbidity removal but expensive due to more energy have been used. For centuries, alum has been widely used as a chemical coagulant in water treatment. Despite the effectiveness in turbidity removal, the usage of alum and other chemical coagulants bring concerns due to its impact to the environment, human health and also economy. Some studies have reported that residual alum and poly aluminium chloride linked to the cause of Alzheimer's disease whereas the synthetic polymers, such as acryl amide will lead to toxic and carcinogenic effects (Muthuraman, et al., 2008).

Highly turbid water can increase the cost of water treatment. Economic-wise, due to high cost incur from using a chemical coagulant, several water treatment companies cannot sustain in the business. Thus, in recent years, extensive studies have been conducted to find cheaper, natural alternatives to chemical coagulants. In this study, *P. tetragonolobus* (winged bean) is chosen as a natural coagulant to replace the presence of aluminium in coagulation and flocculation process as a sustainable approach for the country. *P. tetragonolobus* is chosen because of its abundance in Malaysia and cheap.

The seeds of *P. tetragonolobus* have a high crude protein content that reaches 17% (Dwiani et al., 2014). High protein in *P. tetragonolobus* seeds may be the active agent and has the potential to remove turbidity in water. The positive charge proteins will attract to the negative charged particles, resulting in turbidity removal (Fathinatul & Nithyanandam, 2014). However, there is no specific research about water treatment using seeds of *P. tetragonolobus.* The idea of using this plant as an alternative to chemical coagulant is something new. Therefore, it is an opportunity in determining the effectiveness of *P. tetragonolobus* as water purifier agent especially in removing turbidity. Turbidity is the indicator to represent how cloudy the water is. It is measure in the unit of Nepheleometric Turbidity Unit (NTU). The lower NTU indicates the high quality of water.

In this research, a comparative study is made between natural and chemical coagulants. The comparison is done using jar test with alum as chemical coagulant and *P. tetragonolobus* as natural coagulant. The comparison of these coagulants will be determined based on the percentage of turbidity removal after using a different dosage of coagulant. Previous studies had proven that plant-based natural coagulants are not harmful because they produce biodegradable sludge which can be released in nature without any adverse effect (Šćiban,et al., 2010). Therefore, it is essential to test the effectiveness of *P. tetragonolobus* as another alternative to chemical coagulant because it is able to treat raw water without giving any harmful effect to human health and also to the environment.

The use of *P. tetragonolobus* is also cost-saving because they are abundantly available in Malaysia. Thus, it is easier to find and more cost effective than alum as a coagulant. This cheap alternative can benefits people living in rural areas to treat water for their daily use.

2. Methodology

The water samples were taken from one of the lake at Seksyen 7, Shah Alam. The samples were taken using grab sampling and stored in clean glass containers. Samples were preserved in the refrigerator at 4 °C. All experiments were conducted at Environmental Laboratory, Universiti Teknologi MARA, Shah Alam. The properties of the water sample were analyzed. The initial turbidity of the water sample was 9.99 NTU. Firstly, alum was used as coagulant in order to compare with natural coagulant effectiveness in turbidity removal. The alum dosage used in this study ranging from 20 to 120 ml.

Samples of *P. tetragonolobus* were dried naturally under the sun until the colour turn brown. Then, the seeds are obtained from the seedpod. The seeds were crushed and ground into fine powder. Then, 1g of fine powder was weighed and after weighing, the fine powder was mixed with 100 ml distilled water to make 1% solution. Mixing with distilled water will yield a positive charge from the water-soluble proteins of the seeds. The solution was shaken vigorously for at least 5 minutes to extract the active coagulants before being filtered.

The optimum dosage of coagulant was identified by standard jar test procedure. During the test, coagulant was added by 20 ml increment for each beaker. Then the solution was placed on orbital shaker for mixing at 120 rpm for 3 minutes, followed by slow mixing of 50 rpm for 20 minutes before letting it settle for 30 minutes. The final turbidity concentration for each beaker was then measured. Turbidity was measured using turbidimeter. **Figure 1** shows the photo of *P. tetragonolobus* before being extracted and in powder form.

Figure 1: (a) Raw *P. tetragonolobus*, (b) Dried seeds of *P. tetragonolobus*, (c) *P. tetragonolobus* in powder form.

The percentage of turbidity removal was calculated using equation (1):

$$\text{Percentage of turbidity removal (\%)} = \frac{\text{Initial turbidity} - \text{Final turbidity}}{\text{Initial turbidity}} \times 100\% \quad (1)$$

3. Results and Discussions

That jar test experiments were conducted by using 7 different dosages of Alum which are 0, 20, 40, 60, 80, 100 and 120 ml. Figure 2 illustrates the percentage of turbidity removal by using Alum dosage at initial turbidity of 9.99 NTU.

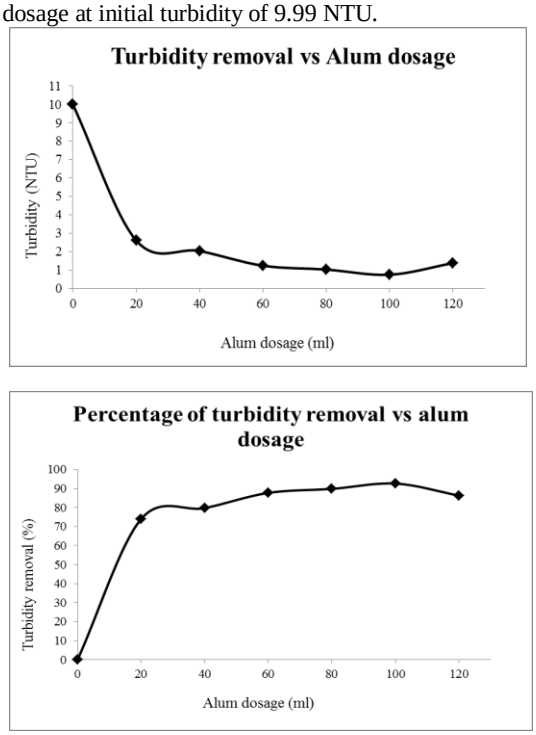

Figure 2: Result of percentage turbidity removal for Aluminium Sulphate as coagulant.

Findings showed that alum is able to reduce the turbidity up to 92%. The percentage of turbidity removal drops from 92.6% to 86.29% where alum has reached its optimum dosage at 100 ml. This is due to alum dosage experiencing over dosage which result to destabilization of colloidal particles (Baghvand et al., 2010). The turbidity constantly drops until it reaches its optimum dosage at 100 ml where turbidity slightly increases from 0.74 NTU to 1.37 NTU. Therefore, the most effective dosage for removing turbidity of 9.99 NTU is 100 ml.

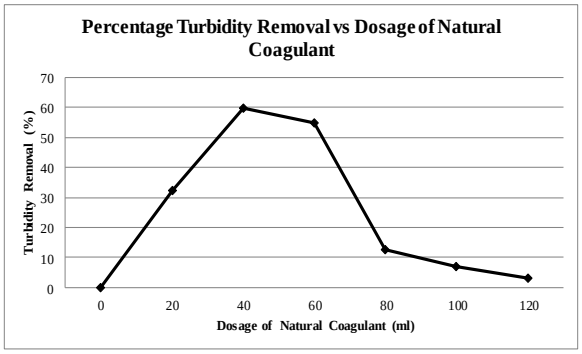

Figure 3: The percentage of turbidity removal by using *Psophocarpus Tetragonolobus* as natural coagulant.

Figure 3 shows the percentage of turbidity removal by using *P. tetragonolobus* as natural coagulant. It shows the optimum dosage needed in removing the turbidity is 40 ml where the tubidity has been reduced to 60% from 99 NTU initial turbidity. 60 ml of *P. tetragonolobus* reduced the turbidity by 55% which can consider as reliable in treating water before discharging to the river. Using dosage more than 60 ml of *P. tetragonolobus* seems not effective as it reduced only 10 percent of the turbidity.

4. Conclusion

It conclusion, *P. tetragonolobus* has a potential as natural coagulant in reducing turbidity in water. It can reduce up to 60% turbidity with the optimum dosage of 40 ml compared to 100 ml alum needed to reduce 92% turbidity. Natural coagulant such as *P. tetragonolobus* not only can increase the water quality yet it is environmental friendly as they do not give harm to human.

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