# POTENTIAL OF *MANGIFERA INDICA* SEED AS A COAGULANT FOR WATER TREATMENT

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## ABSTRACT
Water is a vital resource for human survival and it is essential for sustainable development, hence access to safe drinking water is important to human existing. The water need to go through several treatments to make sure it is not contaminated and safe to be consume. One of the water treatment procedures is coagulation and flocculation process, it is essential process in water treatment and wastewater treatment by using chemical coagulant such as Aluminium Sulphate (alum) as conventional substance. Alum is by far the most coagulant used in water and wastewater treatment, but however studies has shown that usage of Alum did give a bad impact to the health such as Alzheimer's disease and other related health problems. A natural coagulant is preferred is because of its low price, bio-gradation, and it is readily available. This study is to find a potential of a natural coagulant using mango (*Mangifera Indica*) to function like any available conventional coagulant such as Alum, including the processing of mango kernel to become a powder as a natural coagulant. This study will be carried out by using jar testing experiment to investigate coagulation and flocculation using *Mangifera Indica* seed and Alum to three different water samples from sample one from Seri Serdang Lake, sample two from Taman Metropolitan Lake and sample three from Taman Cempaka Lake. Result obtained show that, *Mangifera Indica* has potential in removing water turbidity up to 85.45% removed and according to World Health Organisation (WHO) turbidity removal above 70% with natural coagulant is accepted. As for pH, the value is recorded is between 8.05 to 7.30 after the water treatment it is still in the range of neutral according to pH scale and according to WHO, the standard pH drinking water is between 6.5 to 8.5 is acceptable. To conclude the uses of *Mangifera Indica* has potential as a coagulant in water treatment.

**Keywords***:*
*Alum, Jar Test, Mangifera Indica, Mango Kernel, pH, Turbidity*

## INTRODUCTION

Three quarter of the earth is covered with water with about 1.4 billion km³ including 97% sea water and 3% fresh water. Almost two-third of fresh water is icebergs and glaciers. The available of fresh water for daily use, industry only 0.8% from the total amount of water present on Earth (Dudeney, 2000). Moreover, water is a vital resources for human survival and it is essential for sustainable development, hence access to safe drinking water is important to human existing (Buamah & Ebeigbe, 2017). As water is so important, the water need to go through several treatments to make sure it is not contaminated and safe to be consume.

One of the water treatment procedures is coagulation and flocculation process, it is one of the most widely used techniques for removing suspended particles from water to make it safe and attractive for due to its simplicity and effectiveness (Choy et al., 2014), it is essential process in water treatment and wastewater treatment by using chemical coagulant such as Aluminum sulphate (alum) as conventional substance. When alum is reacting with water it produces positive charged ions, while the dirt particle has negative charge ions it neutralizes the charges thus, a sedimentation is happening at the bottom so it is easy to remove. Flocculation work well together with coagulation in water treatment, after the dirt has clumped together from the coagulation process, the clumps of waste is being removes by flocculation process (Dudeney, 2000).

Many coagulations widely used in conventional water treatment to make the water is safe to be consume. The coagulant consists of several class as inorganic, synthetic organic polymer and natural polymer (Noor,M.J et.al, 2004). Alum is widely used, but it has been the main concern that alum may cause several bad effect on human health such as intestinal constipation, loss of memory (Alzheimer), convulsion, abdominal colic's, loss energy and learning difficulties (Fathinatul & Nithyanandam, 2014). Due to health concern, there is increasing interest of a natural coagulant. Examples of natural coagulant is *Moringa Oleifera*, algae, *Mangifera Indica*, and *Citrus Auratifolia*. A natural coagulant is preferred is because of its low price, bio-gradation, and it is readily available (Yeoh Kar Chuan, 2007), it is cost effective, biodegradable and are presumed to be safe for human health (Sciban et al., 2009).

## LITERATURE REVIEW

The literature review involved an analysis of different types of coagulant for water treatment purpose. The studies involve of natural, plant and fruit based coagulant such as *Moringa Oleifera*, *Mangifera Indica*, and *Citrus Auratifolia*, to works as effective as conventional coagulant in water treatment plant. Next, the studies involved of measuring turbidity and pH value of the water sample. Turbidity is measured the degree of transparency in water due to presence of suspended particles. The higher the total suspended solids in water, the more darkly the colour, the higher the turbidity value. As for pH value is to determine the effect to human health causing from acidity that leave a staining effect corrosive to plumbing and metal (Adeniran & Dummoye, 2017).

Following that, coagulation and flocculation process are physical – chemical method that are widely used in treatment of waste water (Dange & Lad, 2015). Suspended solids in water have a negative charge, it will repel each other when they come in contact. Therefore, suspended solids will remain in suspension and will not clump together and settle out of the water, unless proper coagulation and flocculation is used (Prakash et al., 2014). Coagulations is a chemical process that involve mixing the coagulant with the water sample thus it will neutralized the electrical charges of particles which the particles will clumps together. While for flocculation is a process of slow mixing using Jar test apparatus with different speed and time through the whole process. This process will increase the particle size from invisible to visible suspended particles (Prakash et al., 2014). The process involve, is the collision of the invisible particles that causes to bond together and became larger and heavier thus it settle at the base by the gravity force. The flocculation process is happen after the coagulation process which only takes a very short times while flocculation takes the most time to settle down at the base.

Previous research has shown that *Mangifera Indica* seed has the potential to use as a natural coagulant that is cheap, organic and easy to get the sources. The used of *Mangifera Indica* seed in treating water has remove 92 % of the water turbidity (A. Seghosime et.al,2017). Based on the result, the objective of this journal has been obtain to analyse the effect of *Mangifera Indica* and *Citrus Aurathiifolia* seeds as locally available fruit waste on treatment of water turbidity by using Jar test.Next, *Mangifera Indica* seeds is effective over alum in purification of domestic waste water, based on the result obtain from the Jar testing, has shown that the initial turbidity level is 13 NTU and has decrease to 2 NTU with optimum dosage of 200 mg/L (Adeniran, K. A., & Dunmoye, I.D.,2017). Thus, *Mangifera Indica* seed can be use as an alternative in treating the water since it is environmental friendly and cheaper without any side effects.

Jar testing is method used to study the effect of coagulation, flocculation and sedimentation on treated water. This method is simple and effective way that simulate the process of existing water treatment plant.

## METHODOLOGY

Methodology is a systematic, theoretical analysis of methods applied to the field of study. In this studies, the methodology used was laboratory experiment on determined the effectiveness of natural coagulant and conventional coagulant in removing turbidity from three water sources around Selangor and Kuala Lumpur.

### *Collecting Water Sample*

The water sample was collected from the three different sources from sample one from Seri Serdang Lake, sample two from Taman Metropolitan Lake and sample three from Taman Cempaka Lake by using a steriled jug, then the water was bring immediately to IUKL Environment laboratory for treatment process. In addition, the amount of water sample collected from each sources is three point six (3.6) litres each for the use of water treatment process.

### *Sample Analysis before Treatment*

The water sample from three lake sources undergoes laboratory test at IUKL Environment laboratory. The turbidity and pH values is to be recorded before the water treatment started to be able to compare before and after the treatment.

### *Preparation of Coagulant*

*Mangifera Indica* was washed with tap water and sliced manually using stainless steel knife to obtain the seed. The seed is kept opened to atmosphere about 24 hours for drying as shown in Figure 1 and further dried for 24 hours in hot oven at 105°C as shown in Figure 2 and Figure 3. The dried seed is cut opened to obtain the dried kernel as shown in Figure 4 and Figure 5 shows the kernel has been extracted after 24 hours oven dried at 105°C. The dried kernel was mechanically to fine powder using grinder available in the lab and sieved to make it fine powder appropriate size of about 300 µm as shown in Figure 6. Preparation of Alum was started with measuring 1 grams of alum powder and mixed with 1000 ml distilled water. Then the solution is stir for 10 minutes to be completely dissolved into the distilled water.

Figure 1: The seed is left for air dried for 24 hours

Figure 2: Placing the *Mangifera Indica* Seed to the oven for 24 hours

Figure 3: Mangifera Indica seed after 24 hour Oven dried

Figure 4: The dried Mangifera Indica is cut to obtained the kernel

Figure 5: The kernel has been extracted after 24 hours oven dried at 105°C

Figure 6: The kernel after grinded and sieved

***Treatment Using Coagulant***

Coagulation and Flocculation process started with record the initial reading of turbidity level and pH level for each water sample. Water sample was poured into six label glass beakers with each measurement of 300 ml. The experimental work using the jar tester had been set up as shown in Figure 7. Then, different dosage of Alum stock is pour simultaneously into the beaker and mix immediately with 100 rpm for one minutes. After that, the speed is reduced to 40 rpm for 10 minutes to be able the water sample well mix with the coagulant, following with 10 minutes with zero rpm to allowed the sample to settled down and formed a sedimentation at the base of the beaker.

Following that, the process of using Mangifera Indica stock as a coagulant was by pouring simultaneously into the six label glass beakers with 150 rpm for one minutes, then the speed was reduced to 45 rpm for 10 minutes to allow the coagulant and the water sample well mixed and following with 60 minutes of settlement with zero rpm. Figure 8 shows the settlement process after water treatment process. As a result of the settlement process, the water sample is collected by using a glass pipet to extract the water sample without disrupting the formation of sediment at the base to obtain pH and turbidity samples as shown in Figure 9. Finally, the pH and turbidity results of treated water were determined and recorded by using pH meter and turbidimeter as shown in Figure 10 and Figure 11.

Figure 7: Jar Tester set up

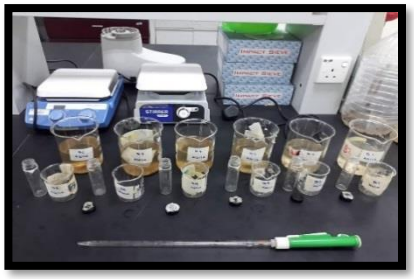

Figure 8: Settlement process after water treatment

Figure 9: Extract the water sample to obtain pH and turbidity sample

Figure 10: PH results were recorded by using pH meter

Figure 11: Turbidity results were recorded by using Turbidimeter

## RESULTS AND DISCUSSION

Table 1 shows the result obtained of initial and residual reading of turbidity and pH value of water sample 1, 2 and 3 with different dosage of Alum stock solution added. According to Table 1, the initial turbidity for water sample 1, 2 and 3 is 62.13 NTU, 46.43 NTU and 39.53 NTU it is less than 50 NTU and 100 NTU it is moderate, low and low turbidity (Noor M.J et.al, 2004). After the treatment using Alum, the turbidity value is decreased as stated the Malaysia guideline for Drinking Water Supplies is less than 5 NTU (Noor M.J et.al, 2004). In short, the lower the turbidity value obtained, the clearer the water is. As result shows that, the coagulant added effectively neutralized the negative charges in colloid in the water sample, thus a sediment is

formed at the bottom of the beaker after 10 minutes of settlement using Alum. The turbidity percentage removal after the treatment is in between 65.34 % to 99.12 % removed. Optimum dosage is achieved by the lowest turbidity value recorded after the treatment, the lowest turbidity value recorded for sample 1, 2 and 3 is 2.23 NTU, 0.41 NTU and 1.44 NTU. Figure 12 shows, the pattern of the experiment according to turbidity (NTU) versus the Alum stock solution added to the three water samples after the treatment.

The initial pH values for sample 1, 2 and 3 is recorded at 7.79, 7.90 and 6.88 which were consider as neutral in pH scale. pH of water treated of Malaysia standard is between 6.5 and 9 (Noor M. J et.al, 2004). The pH value obtained after the treatment is between 6.51 to 8.04, it is still in the range of neutral according to pH scale and Malaysian standard. In addition, according to National Water Quality Standard for Malaysia (NWQS) the pH is in the range in Class IIA and IIB. Figure 13 shows the pattern of the experiment according to pH versus the Alum stock solution added to the three water samples after the treatment.

The initial and residual reading of turbidity and pH readings using *Mangifera Indica* as a coagulant for sample 1, 2 and 3. The initial turbidity and pH readings for all water sample is same as stated above, it is moderate and low turbidity type. After the treatment using *Mangifera Indica* seed, the turbidity value is decreased between 20.3 NTU to 6.76 NTU, the turbidity reading after the treatment decreased almost half compare to initial turbidity reading. According to World Health Organisation (WHO) stated that turbidity removal above 70% with natural coagulant is accepted (A. Seghosime et.al, 2017). Based on the result obtained the turbidity percentage removal after the treatment is between 48.65 % to 85.45 % removed. As shown in Table 1 below, the higher dosage of *Mangifera Indica* added to the water sample, the higher the turbidity value compared to the lower dosage of coagulant added. The reason the more dosage added, the higher the turbidity value is because of the amount of colloid particle in the *Mangifera Indica* coagulant is larger it is causing the *Mangifera Indica* powder does not well mixed with distilled water, and has more colloid compare to the small dosage coagulant added. Figure 14 shows the pattern of the experiment according to turbidity (NTU) versus the *Mangifera Indica* stock solution added to the three water samples after the treatment.

Stated in Table 1 below, the initial pH values is recorded for water sample 1, 2 and 3 is 7.79, 7.90 and 6.88, which is consider as neutral in pH scale. Figure 15 shows the pattern of the experiment according to pH versus the *Mangifera Indica* stock solution added to the three water samples after the treatment. The pH value is recorded between 6.51 to 8.05 after the treatment using *Mangifera Indica* seed it is still in the range of neutral according to pH scale. According to NWQS the allowable pH is between six to nine for Class IIB the uses for recreational use body contact and according to World Health Organisation (WHO), the standard pH drinking water is between 6.5 to 8.5 is acceptable (Addo,2011).

Table 1: Initial and Residual Experiment Result Using Alum and *Mangifera Indica* for 3 water samples

| | | Water Sample | | | | | |
|---|---|---|---|---|---|---|---|
| | | Sample 1: Seri Serdang Lake | | Sample 2: Taman Metropolitan Lake | | Sample 3: Taman Cempaka Lake | |
| Initial Reading | | | | | | | |
| | | Turbidity (NTU) | pH | Turbidity (NTU) | pH | Turbidity (NTU) | pH |
| | | 62.13 | 7.79 | 46.43 | 7.90 | 39.53 | 6.88 |
| Residual Reading | | | | | | | |
| Coagulant | Stock Solution Dosage (ml) | Turbidity (NTU) | pH | Turbidity (NTU) | pH | Turbidity (NTU) | pH |
| Alum | 3 | 13.77 | 7.74 | 4.02 | 8.04 | 13.70 | 7.06 |
| | 6 | 8.54 | 7.49 | 1.26 | 7.76 | 6.12 | 6.87 |
| | 9 | 6.62 | 7.44 | 0.45 | 7.60 | 2.66 | 6.76 |
| | 12 | 3.39 | 7.26 | 0.76 | 7.60 | 1.96 | 6.93 |
| | 15 | 3.45 | 7.40 | 0.66 | 7.56 | 1.44 | 6.59 |
| | 18 | 2.23 | 7.34 | 0.41 | 7.52 | 2.01 | 6.51 |
| *Mangifera Indica* | 9 | 11.63 | 7.18 | 6.76 | 8.05 | 14.90 | 7.07 |
| | 18 | 12.90 | 7.20 | 8.34 | 7.80 | 16.37 | 6.85 |
| | 27 | 13.93 | 6.91 | 9.64 | 7.72 | 17.60 | 6.70 |
| | 36 | 15.93 | 7.30 | 11.63 | 7.56 | 20.30 | 6.57 |
| | 45 | 15.40 | 6.68 | 12.07 | 7.44 | 18.57 | 6.51 |
| | 54 | 17.30 | 6.66 | 13.33 | 7.30 | 19.27 | 6.36 |

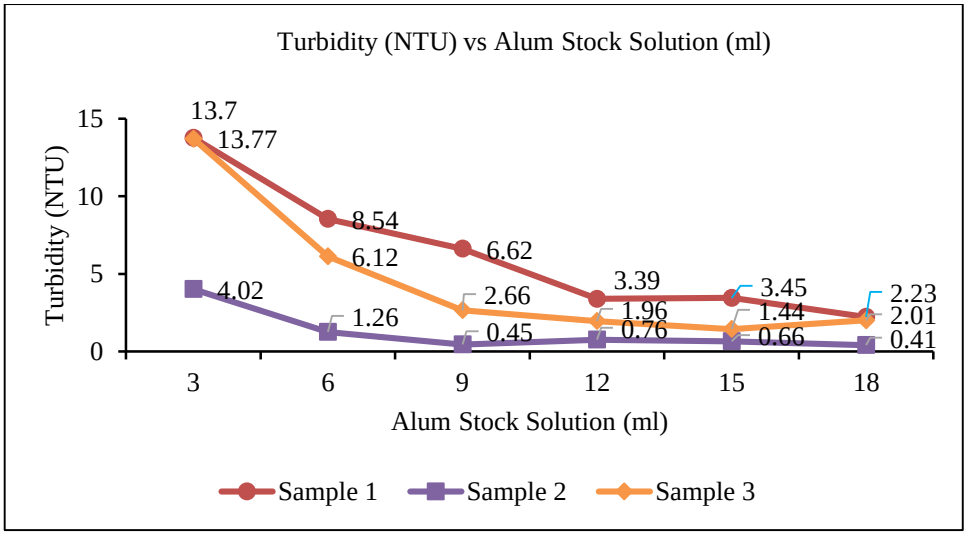


Figure 12: Turbidity (NTU) versus Alum stock solution (ml) for water sample 1, 2 and 3

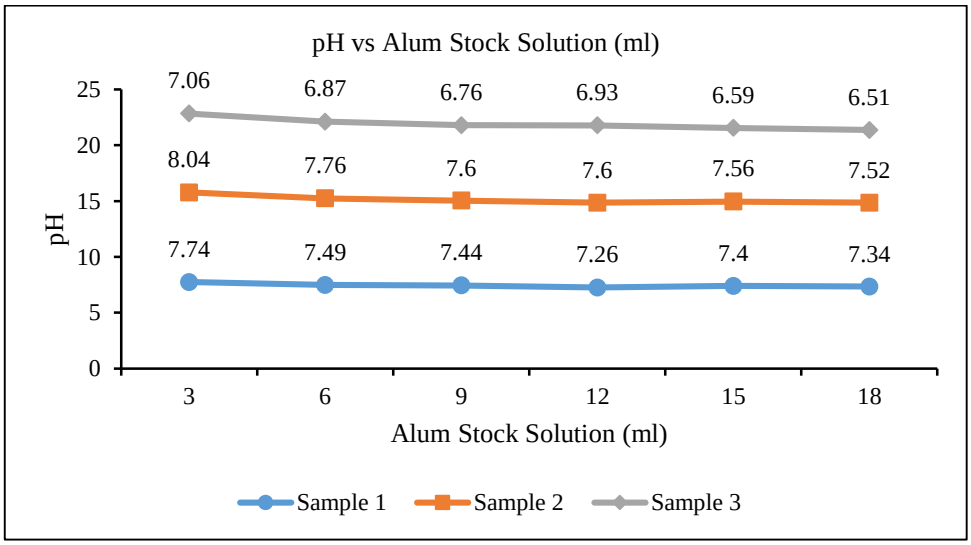


Figure 13: pH versus Alum stock solution (ml) for water sample 1, 2 and 3

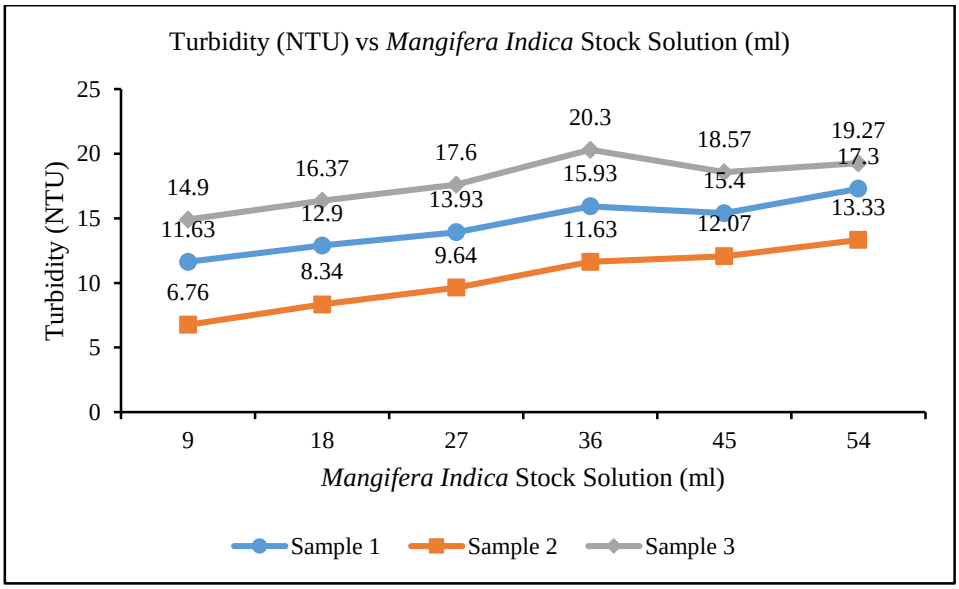


Figure 14: Turbidity (NTU) versus *Mangifera Indica* stock solution (ml) for water sample 1, 2 and 3

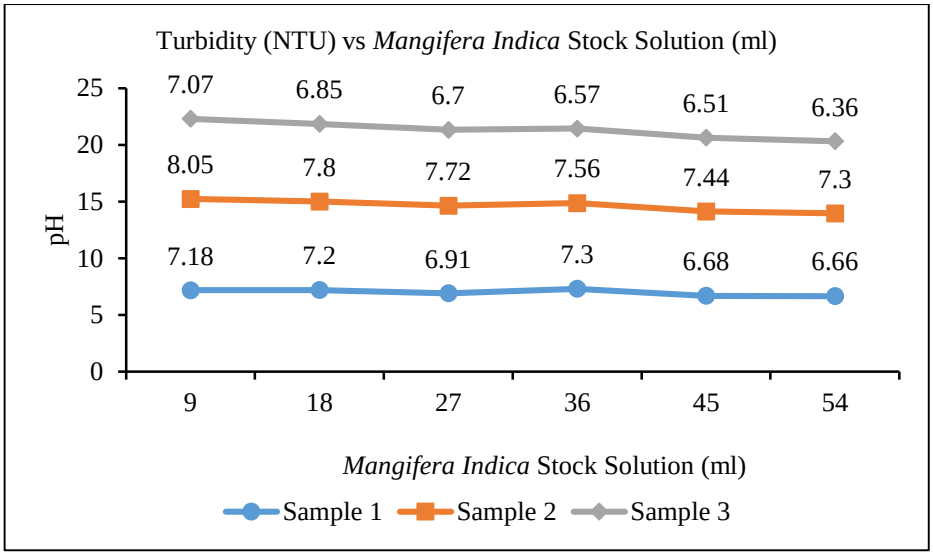


Figure 15: pH versus Mangifera *Indica* stock solution (ml) for water sample 1, 2 and 3

## CONCLUSION

The conclusion of this researched studies are outline as follows:

1. Objective 1: To determine turbidity and pH using *Mangifera Indica* seed and alum comparing the results of 3 different sources by using Jar test.
   The studies are successful as researched involved in determine turbidity and pH using different types of coagulant pouring into 3 water samples with using Jar test method, are able to make a comparison between the usage of Alum and Mangifera Indica as a coagulant in all water sample. As a result, the used of Alum and Mangifera Indica as a coagulant able to reduce the turbidity in water, as for pH does not effected by the coagulant added as it remain neutral before and after the treatment.
2. Objective 2: To determine the optimum dosage of the *Mangifera Indica* seed by Jar test method.
   To determine the optimum dosage of a coagulant is by the most turbidity reduction compare to few different dosage of a coagulant added. For Mangifera Indica the stock solution added is from 9, 18, 27,36,45,54 ml. Based on the result obtain through Jar test from week 18 to week 23 in Environment Laboratory Block 9, the optimum dosage of *Mangifera Indica* is at 9 ml of coagulant added to the three water sample with turbidity removal 62.31% to 85.45%.
3. Objective 3: Compare the effectiveness of alum and *Mangifera Indica* seed as coagulant.
   According to the result obtained from the laboratory experiment, the effectiveness of using Alum as coagulant cannot be denied as it is effective in removing water turbidity almost 99.12%. Following that, the percentage removal by using *Mangifera Indica* as coagulant is able to remove up to 85.45%. In conclusion, the usage of Alum is more effective compare to *Mangifera Indica.*

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