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Study of using *Moringa Oleifera* seeds as natural coagulant for turbidity removal in kitchen wastewater

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Abstract: Nowadays, kitchen wastewater becomes an environmental issue that can cause negative impacts on human health and the environment since it becomes deteriorates each year. In order to reduce this issue, *M.Oleifera* seeds which acts as natural coagulant were used to take place in the coagulation process so that the turbidity can be reduce effectively. The water parameters such as coagulant dosage, stirring speed and settling time were manipulated in the Jar test experiment to analyze the efficiency of the *M.Oleifera* at the end of the study. Results obtained depicted that the optimum coagulant dosage was 2.5 g/L with turbidity removal 83.55 %, stirring speed was 120 rpm with turbidity removal 53.23 % and settling time was 30 minutes with turbidity removal 43.79 %. As a result, it can be inferred that *M.Oleifera* seeds powder can be utilized as a natural coagulant alternative to synthetic coagulants

Keywords: Kitchen Wastewater, *M.Oleifera* Seeds

1. Introduction

Kitchen wastewater (KWW) which refers to the grey-water has getting many attentions from the society due to its organic contaminants and oil and grease from human daily domestic activities such as cooking, washing plates and cleaning. In cafeterias, hotels, and other commercial buildings, as well as in residential homes, the amount of kitchen wastewater generated by humans is often very high. Basically, the kitchen wastewater contributes as the primary contaminants being proteins, carbohydrates, detergents, oil and grease and other dissolved and suspended compound [1]. This type of wastewater causes hazardous effects towards the environment, leads to the occurrence of eutrophication in water bodies and choking of pipes from the sewer system [2]. KWW can be treated depending on its quality and composition since it may have a low degree of pollution, rapidly biodegradable organic components and low content of pathogen [3]. KWW should be managed properly and effectively to ensure the water pollution from the domestic activities can be minimized so that the human beings and the surroundings will not become more and more deteriorate. In this case, coagulation-flocculation process plays huge role in the wastewater treatment to reduce the turbidity of the water.

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In the field of wastewater treatment, synthetic and natural coagulants have been used to treat wastewater more efficiently. Synthetic coagulants include ferrous sulphate ($Fe\ (SO_4)$), aluminium sulphate or alum ($Al_2(SO_4)_3$) and Poly Aluminium Chloride (PAC) ($Al_2(OH)_3Cl_3)_{10}$, while natural coagulants can be obtained from tropical plants, microorganisms and animals by extraction processes [4]. However, the synthetic coagulants, especially $Al_2(SO_4)_3$ have been proven that leads to disadvantage such as cause some health, economic and environmental problems when used, with neurological disorders for example percent dementia and Alzheimer's disease induction [5]. Besides that, aluminium also can negatively impact human health, including intestinal obstruction, memory loss, cramps, stomach colic, fatigue and learning problem [6]. Today, *M.Oleifera* seeds is well-known and recommend applying in water treatment field as a natural coagulant to treat the wastewater effluents. This is because it contains a natural organic polymer and biodegradable materials which can act as a suitable natural coagulant. Not only that, *M.Oleifera* also can help to remove high levels of pollution and generate a non-hazardous and low volume of sludge throughout the coagulation activity respectively. When compared to alum or other ferric salts, it softens hard water by containing seed proteins, which are essential for water purification, as well as antioxidant compounds, which may be helpful in wastewater treatment [7].

2. Materials and Methods

2.1 Materials

M.Oleifera seeds were obtained from the Mutiara Rini Homes 2, Skudai, Johor by handpicked from the *M.Oleifera* tree. There is a total of 12 L of raw kitchen wastewater was collected from the cafeteria at the campus of Universiti Tun Hussein Onn Malaysia (UTHM), Pagoh. These effluents were collected in a 12 L of HDPE bottle. For preservation, the kitchen wastewater collected was added into the effluents and kept in the refrigerator room in the Environmental Engineering Laboratory in Universiti Tun Hussein Onn Malaysia, Pagoh.

2.2 Methods

2.2.1 Jar Test

In the Jar test experiment, several procedures were followed properly to ensure the accuracy of the results obtained as shown in Figure 1. Firstly, 300 ml of kitchen wastewater was poured into six beakers with 1000 ml volume accordingly. Secondly, the initial pH and DO for these six beakers containing kitchen wastewater samples were determined by using the pH meter and DO meter. Thirdly, the wastewater was stirred at 120 rpm for 3 minutes before the coagulant adding to it. After 3 minutes, the coagulant in powder form was added and started again at 140 rpm for 2 minutes (rapid mixing). Next, the mixing speed was adjusted to 30 rpm, and it was stirred for 15 minutes (slow mixing). After that, the beakers were placed on a flat surface so that the floc can settle down at the bottom of the beakers. The beakers were left there for 15 minutes to let the floc have enough time to complete the settlement. The procedure was repeated by adjusting the coagulant dosage (0.5-2.5 g/L), stirring speed (100-140 rpm) and settling time (25-45 min) throughout the experiment to get the optimum values for these parameters. Data and reading for turbidity, COD, TSS and TDS were analysed for the kitchen wastewater in the cafeteria at UTHM Pagoh Campus.

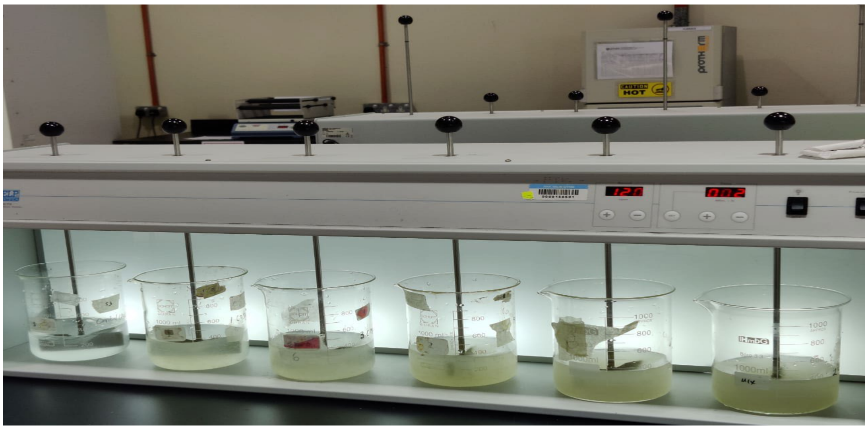

Figure 1: Jar test conducted in the experiment

2.2.2 Fourier-transformed infrared radiation (FTIR)

Throughout the experiment, the Fourier-transformed infrared radiation (FTIR) spectrophotometer was applied to investigate the functional groups that contains in the *M.Oleifera* seeds powder. The spectrum of *M.Oleifera* seeds powder as natural coagulant was collected from a range of 450 to 4000 cm^{-1}. The nature of the sample's surface and functional groups was investigated using an Agilent Technologies Cary 600 Series FTIR Spectrometer in transmission mode.

2.3 Equations

In this research, turbidity removal is calculated in order to analyze the efficiency of the *M.Oleifera* seeds by applying the formula as shown in Eq. 1. Besides that, total suspended solids and total dissolved solids of the kitchen wastewater were also calculated by using the Eq.2 and Eq.3 respectively.

$$Turbidity\ Removal\ Efficiency, TRE\ (\%) = \left[\frac{T0 - T}{T0}\right] x\ 100\% \quad Eq. 1$$

$T0$= initial readings for the turbidity of the effluents, NTU

T= final readings for the turbidity of the effluents, NTU

$$Total\ Suspended\ Solids, mg/L = \frac{A - B}{C}\ x\ 10^6 \quad Eq. 2$$

where; A = weight of filter + dried solids, g

B = weight of dry empty filter, g

C= volume of sample used, mL

$$Total\ Dissolved\ Solids, mg/L = \frac{A - B}{C}\ x\ 10^6 \quad Eq. 3$$

where; A = weight of evaporating dish + samples after drying, g

B = weight of dry evaporating dish, g

C= volume of sample used, mL

3. Results and Discussion

3.1 FTIR Analysis of *Moringa Oleifera* seeds powder

Figure 2 indicates the FTIR analysis for the *M.Oleifera* seeds powder. Based on the FTIR spectrum illustrated in Figure 2, there are 11 peaks produced. The peaks achieved at 3288.44 cm^{-1}, 2924.01 cm^{-1}, 2854.16 cm^{-1},1744.54 cm^{-1}, 1545.78 cm^{-1}, 1539.22 cm^{-1}, 1451.85 cm^{-1}, 1232.29 cm^{-1}, 1054.67 cm^{-1}, 793.65 cm^{-1}, and 515.93 cm^{-1}. According to the figure, the highest peak at 3288.44 cm^{-1} shows that the presence of alkynes, phenols and alcohols, carboxylic acids, amines and amides. Alkynes have presented absorption ranges between 3300 to 3200 cm^{-1} and affected by ≡C-H stretch. On the other hand, phenols and alcohols shows absorption ranges between 3600 to 3100 cm^{-1} and affected by O-H stretch. Furthermore, the carboxylic acids show in the *M.Oleifera* seeds powder consists absorption ranges between 3400 to 2400 cm^{-1} and affected by O-H stretch. Lastly, amines are also determined at this peak. In this case, amines can be separated into primary and secondary amines. Both of them indicate absorption ranges between 3500 to 3100 cm^{-1} and affected by N-H stretch.

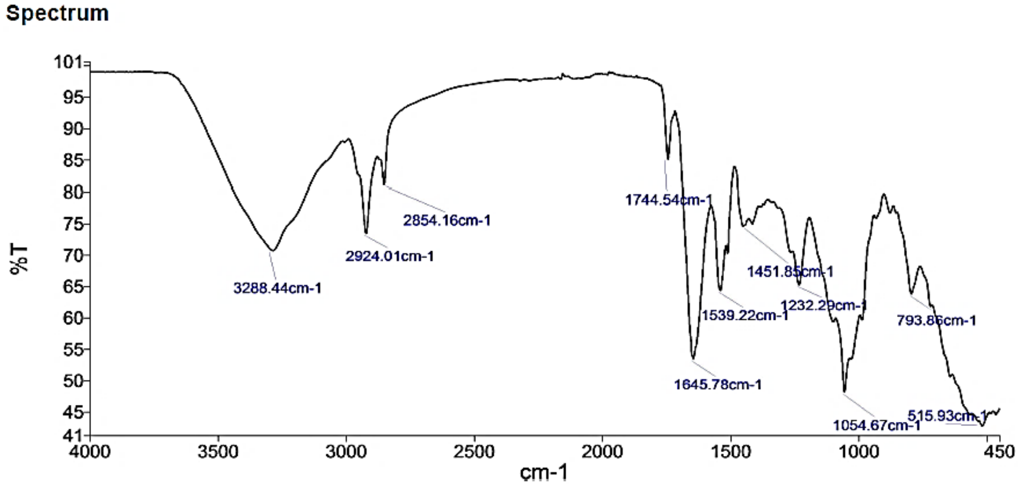

Figure 2: FTIR analysis for the *M.Oleifera* seeds powder

3.2 Effect of coagulant dosage on turbidity

According to the Figure 3, the effect of coagulant dosage on turbidity was shown clearly. From the figure, it can be observed that the coagulant dosage has a major impact on the coagulating activity's performance. The effect of the coagulant dosage was taken at 0.50,1.00,1.50,2.00 and 2.50 g/L. Throughout the experiment, the turbidity of the kitchen wastewater decreases as the coagulant dosage increases from time to time. At the beginning, the initial turbidity of the kitchen wastewater is 124 NTU. However, when the coagulant starts to add into the kitchen wastewater, the turbidity of the kitchen wastewater drops rapidly. At the end of the experiment, the final turbidity of the kitchen wastewater become 20.40 NTU. Basically, the amount of coagulant used determines the amounts of flocs produced, as the coagulant's charges neutralise the greywater particles and encourage them to stick together[8]. Because greywater particles have little energy, a low dosage will neutralise them, resulting in weak and microscopic flocs.In this experiment, the optimum amount of coagulant dosage is 2.5 mg/L where the highest turbidity removal efficiency is 83.55 %.

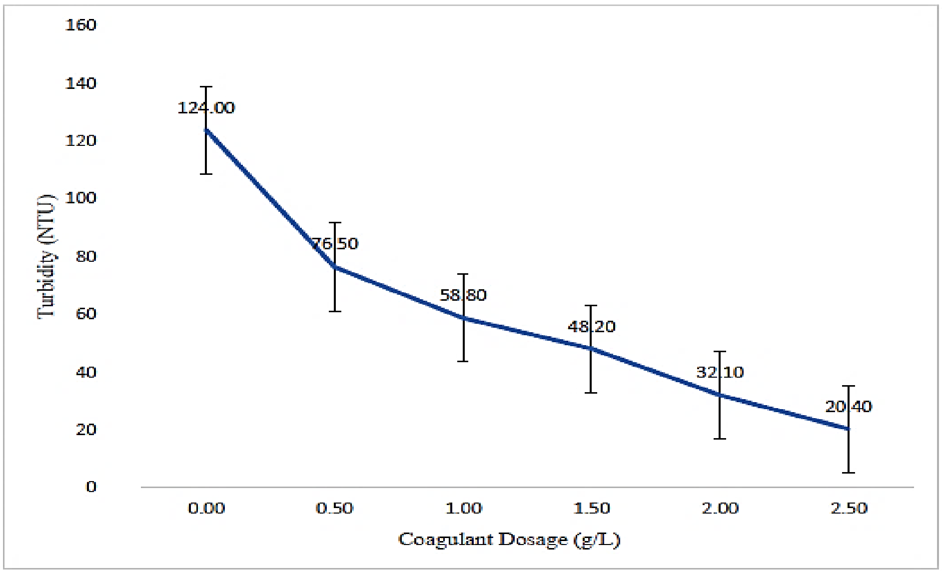

Figure 3: Effect of coagulant dosage on turbidity

3.3 Effect of stirring speed on turbidity

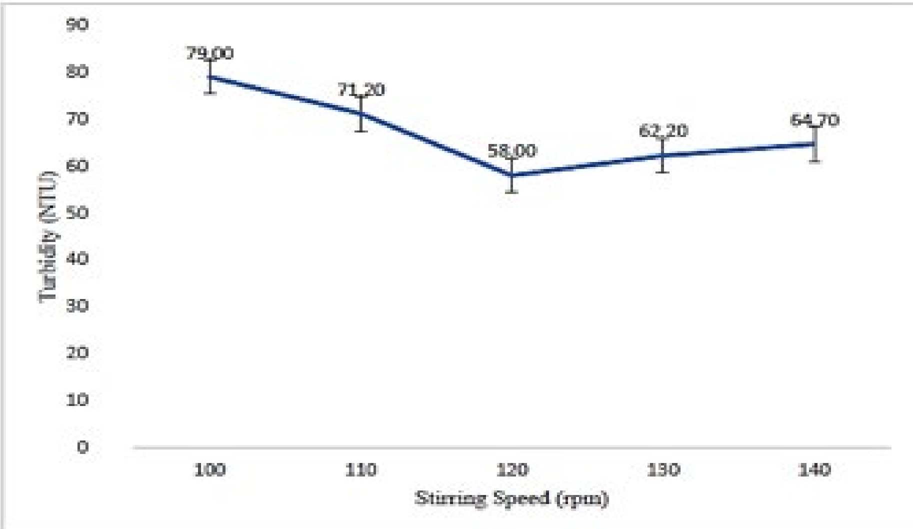

Figure 4: Effect of stirring speed on turbidity

Stirring speed also can takes place in the coagulation process. The stirring speed was manipulated at 100,110,120,130 and 140 rpm. The effect of the stirring speed on the turbidity for the kitchen wastewater was shown in Figure 4. From the figure, the stirring speed increases from 100 rpm until 120 rpm. When the stirring speed is 100 rpm, the turbidity of the kitchen wastewater is 79.0 NTU. Then, it decreases to 71.2 NTU at 110 rpm. Next, the turbidity drops to 58.0 NTU when the stirring speed is 120 rpm. However, the turbidity of the kitchen wastewater begins increase from 62.2 NTU to 64.7 NTU at the 130 rpm and 140 rpm respectively.Since a lower speed encourages floc formation, but higher speeds may break up the created flocs, resulting in reduced turbidity reduction, a stirring speed of 120 rpm (low stirring speed) yielded the maximum turbidity reduction at the varied concentrations tested[9]. The turbidity removal for kitchen wastewater at 120 rpm is 53.23% compared to other stirring speed. As a result, the ideal stirring speed is critical for guaranteeing particle coagulation, but it should not be too high to cause floc disruption or ripping.

3.4 Effect of settling time on turbidity

Based on the Figure 5, the effect of settling time also can be observed. The settling time was adjusted at 25,30,35,40 and 45 minutes. At the beginning, the turbidity was 72.10 NTU at 25 minutes. After that, the turbidity of the kitchen wastewater drops to 69.7 NTU at 30 minutes. However, it starts increase to 76.0 NTU and 77.0 NTU at 35 minutes and 40 minutes respectively. Lastly, it hits the highest values of turbidity which is 86.5 NTU at 45 minutes. Hence, it can conclude that 30 minutes is the optimum settling time for *M.Oleifera* seeds powder to settle down. , the maximum turbidity reduction for kitchen wastewater was 43.79 %, indicating that the coagulant function is 43.79 % efficient in reducing wastewater turbidity. Furthermore, the researchers discovered that when pinecone extract was used as a natural coagulant to treat turbid water, the turbidity removal efficiency decreased dramatically in the 2nd, 3rd, and 4th hours, as opposed to the 1st hour, when there was increased turbidity removal activity [10]. This is because the number of soluble proteins present in the turbid water was at its peak during the first hour. During the 2nd, 3rd, and 4th hours, however, suspended materials remained in the turbid water, causing widespread turbidity. As a result, soluble proteins take longer to coagulate while also guaranteeing that suspended particles in turbid water are bonded together.

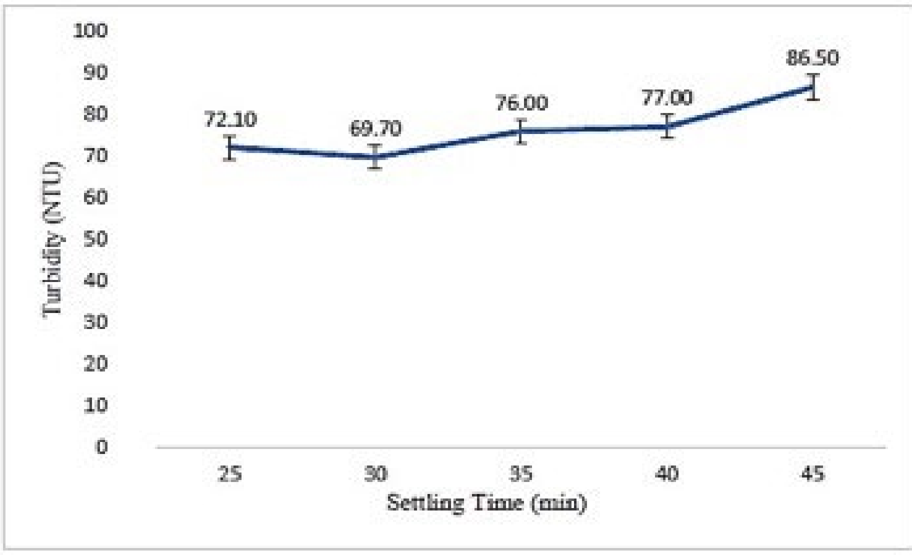

Figure 5: Effect of settling time on turbidity

4. Conclusion

The goals and objectives indicated above were met during this study. The FTIR spectrophotometer was used to characterize the *M.Oleifera* seeds powder, and the findings revealed that the *M.Oleifera* seeds powder included functional groups such as carboxylic acids, amides, esters, and carbonyl (aldehydes and ketones).Additionally, alkanes, alkenes, alkynes, nitriles, aromatic rings, and nitro groups were detected in the *M.Oleifera* seeds powder using an FTIR spectrophotometer. The FTIR test can helps in adsorption and charge neutralization processes in order to reduce the turbidity. Besides that, kitchen wastewater sample metrics including COD, TSS, and TDS were analyzed and connected to the various water classes and applications. In this research, COD value for the kitchen wastewater obtained was 594 mg/L which is quite high and under CLASS V in the National Water Quality Standard for Malaysia. Moreover, the average TSS value and TDS value for the kitchen wastewater were 180.67 mg/L and 566.67 mg/L respectively. In fact, the effects of *M.Oleifera* seeds powder dosage (0.5,1.0,1.5,2.0,2.5 g/L), stirring speed (100,110,120,130,140 rpm), and settling time (25, 30, 35, 40, 45 minutes) on the performance of turbidity in the kitchen wastewater samples employed were effectively determined in this study. The efficiency of turbidity removal was evaluated between these specified parameters, and the best values for each investigated parameter were found. *M.Oleifera* seeds powder dose of 2.5 g/L, stirring speed of 120 rpm, and settling time of 30 minutes are the ideal values. The *M.Oleifera* seeds powder produced the highest efficient turbidity reduction percentages of 83.55 %, 53.23 %, and 43.79 %, respectively, under these circumstances. As a result, it can be inferred that *M.Oleifera* seeds powder can be utilized as a natural coagulant alternative to synthetic coagulants such as alum, which is widely employed in numerous sectors but has significant environmental and human health consequences.

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References

[1] T. Ukamaka, C. Nwadiuto, & O. S. Enyi, A Filtration System for Treatment of Kitchen Waste Water for Re-Use. International Journal of Scientific & Engineering Research, 6(10), 596–600. http://www.ijser.org (2015)

[2] H. Hendrawati, I. R. Yuliastri, Nurhasni, E. Rohaeti, H. Effendi, & L. K. Darusman, The use of Moringa Oleifera Seed Powder as Coagulant to Improve the Quality of Wastewater and Ground Water. *IOP Conference Series: Earth and Environmental Science*, *31*(1). https://doi.org/10.1088/1755-1315/31/1/012033 (2016)

[3] I. E. Uwidia, Treatment of Kitchen Wastewater using Aerobic Biological Method and Sand-Bed Filtration. International Journal of Chemistry, 12(2), 12. https://doi.org/10.5539/ijc.v12n2p12 (2020)

[4] S. Hussain, A. S. Ghouri, & A. Ahmad, Erratum to "Pine cone extract as natural coagulant for purification of turbid water" [Heliyon 5 (3) (March 2019) e01420] (S2405844018367690) (10.1016/j.heliyon.2019 e01420). *Heliyon*, *5*(4), e01500. https://doi.org/10.1016/j.heliyon.2019.e01500 (2019)

[5] R. Parwin, & K. Karar Paul, Overview of Applications of Kitchen Wastewater and Its Treatment. *Journal of Hazardous, Toxic, and Radioactive Waste*, *24*(2), 04019041. https://doi.org/10.1061/(asce)hz.2153-5515.0000482 (2020)

[6] J., S. et.al (2017). Wastewater Treatment using Natural Coagulants. International Journal of Civil Engineering, 4(3), 40–42. https://doi.org/10.14445/23488352/ijce-v4i3p109

[7] M. Sulaiman, D. Andrawus Zhigila, K. Mohammed, D. Mohammed Umar, B. Aliyu, & F. A. Manan Moringa oleifera seed as alternative natural coagulant for potential application in water treatment: A review. *Journal of Advanced Review on Scientific Research Journal Homepage*, *30*(1), 1–11. www.akademiabaru.com/arms.html , (2017)

[8] M. E. Tsie, F. Ntuli, & T. Lekgoba, Effectiveness of using milled moringa oleifera seeds as a natural coagulant in waste water treatment. *Test Engineering and Management*, *82*(January), 5686–5690 (2020)

[9] S. N. Ugwu, A. F. Umuokoro, E. A. Echiegu, B. O. Ugwuishiwu, & C. C. Enweremadu, Comparative study of the use of natural and artificial coagulants for the treatment of sullage (domestic wastewater). *Cogent Engineering*, *4*(1). https://doi.org/10.1080/23311916.2017.1365676 (2017)

[10] N. F. A. Yani, N. Ismail, & K. S. Oh, Potential of using Hibiscus Sabdariffa in treating greywater. *AIP Conference Proceedings*, *2137*(August). https://doi.org/10.1063/1.5120993 (2019)