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Use of Aloe Vera and Moringa Oleifera as Biocoagulant in Palm Oil Industry

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Abstract:
Production activities in the palm oil industry generate waste, which is commonly called as Palm Oil Mill Effluent (POME). POME is a thick brownish viscous liquid waste, slurry, high in colloidal suspension and has an unpleasant odor. One of the processing units on its waste water treatment plant is coagulation-flocculation using synthetic coagulant. The improperly dosage causes fluctuative effluent quality of the waste water treatment plant. Therefore, the researcher had analyze the use of Aloe vera and Moringa seeds as biocoagulant on oil industry's waste water treatment plant. Based on the results of the test, the optimum concentration of Aloe vera 60 mL/L proved the removal efficiency of COD was 77,51%; TSS was 45,29%; and turbidity was 79,51%. Moreover, the optimum concentration of moringa seeds 12 mL/L proved the removal efficiency of COD was 70,67%; TSS was 40,52%; and turbidity was 75,8%. Whereas, the optimum concentration of mixed Aloe vera and moringa seeds is 32 mL/L proved the removal efficiency of COD was 76,83%; TSS was 40,3%; and turbidity was 74,57%.

Keyword: *Aloe vera, Biocoagulant, Moringa seeds, Natural coagulant*

I. INTRODUCTION

The vegetable oil industry in Indonesia is currently very strong due to an increase in thyoe amount of palm oil production in line with community needs. Over the years, oil palm has an important role in the economy in Indonesia [17]. Palm oil production is increasing year by year. Another impact of its development is palm oil liquid waste, also known as Palm Oil Mill Effluent or POME. Palm Oil Mill Effluent waste comes from the processing of oil palm fruit into Crude Palm Oil (CPO). Total Suspended Solids content in palm oil wastewater is quite high. If this TSS is carried to the stream, it will cause some problems such as silting of river water [13].The average of TSS content in the vegetable oil industry wastewater in 2017 is around 129 mg / L. This improves the quality of wastewater based on the East Java Governor Regulation No. 72 of 2013.

Coagulation - flocculation is the one of technology to reduce TSS content in palm oil wastewater. Coagulation is a destabilizing process with a fast stirring process, while flocculation is the process of forming flocs with slow stirring of destabilized particles. After coagulation (destabilization process) and flocculation (formation of flocs), leads to the separating process where the floc is delivered properly through gravitation or screening process [6]. The coagulation-flocculation process can use coagulants from both synthetic materials and natural materials. In the coagulation-flocculation process, it is common to use synthetic coagulants and flocculants. In the coagulation-flocculation process commonly uses alum-as coagulants. However, this method still has shortcomings in its implementation because the process is too complex and need a high costs [12]. In addition, water treatment is very expensive for developing countries and requires the use of synthetic materials that have some impacts on human's health [1].

Many of the oil industry uses lime as a coagulant and PAC as a flocculant. The dosage given by the operator is inappropriate at all times because the measurement is just according to the operator's estimations. Thus causing fluctuating effluent, even exceeding wastewater quality standards in TSS (Total Suspended Solids) parameters. In addition, the use of synthetic materials also increase the volume of sludges [11].

The use of natural coagulants is expected to cut the treatment costs and also minimize the environment's impact that occurs from the bramuse of synthetic materials that have side effects. The use of this natural coagulant will be cheaper than the use of synthetic coagulants [8].

Some plants available as biocoagulants are cactus, dragon fruit stems [14], Coccinia indika and Okara [10]. In addition to these plants, Moringa seeds can also be used as biocoagulants [15].

Aloe vera is an option as a subtitution of synthetic coagulants. This is because it contains mucilago, the same as cactus which is proven to be able to purify the water. The choice of aloe

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vera as a biocoagulant is because aloe vera is easy to get and low prices compared to synthetic coagulants [14].

Moringa seeds are also an alternative biocoagulant that can be used. Moringa seeds have been used as biocoagulant since long time ago. Since 1980, Moringa seeds has been used as a water purifier by the Department of Environmental Engineering ITB [13]. The skin of the moringa seeds contains a protein that will be positively charged when it is dissolved in water. This resembles a synthetic coagulant working principle that is possitively charged [5].However, the reseacher would like to analyze the use of Aloe vera and Moringa oleifera as biocoagulant on reducing COD, TSS, and turbidity in palm oil's wastewater.

II. Methods

Making of Aloe vera Biocoagulants

Aloe vera is washed to remove dirt on *Aloe vera* skin. Then cut the inside (aloe vera meat) into several smaller pieces and smooth it with a blender until it becomes porridge. 500 mL of *Aloe vera* gel then dissolved in 500 mL of distilled water and stirred using a magnetic stirrer for 30 minutes. The filtrate is then stored in a clean and dry container. This filtrate can be stored in a refrigerator not more than 1 week [9].

Making of moringa seed biocoagulants

Moringa seeds used are old Moringa seeds. The seeds and shells were cleaned and then smoothed into a powder by using blender and dried in an oven at 105°C for 30 minutes. It aims to homogenize and reduce the water content to a constant of less than 10% [15]. If the water content in moringa seeds is high, then the ability to absorb is smaller because the active substance is not on the surface of Moringa seeds but it is covered with water so that the moisture of Moringa seeds must be small [4].Then, 50 grams of Moringa seed powder were dissolved in 500 mL of distilled water and stirred using a magnetic stirrer at 50°C for 1 hour. Then, the supernatant from the solution of moringa seed powder is taken using a pipette.

Implementation of Jar Test

The test was done using a jar test. Jar test is a method that is widely used for coagulation-flocculation processes. Before operating the jar test, the sample was first shaken to get a homogeneous sample (Amruta & Munavalli, 2017).

There are 500 mL of sample volume on each beaker which has been added with aloe vera and Moringa seeds with different volumes on each beaker. The beaker is then stirred at various speeds consisting of rapid stirring (300 rpm) for 2 minutes followed by slow stirring (30 rpm) for 15 minutes. After stirring, leave the solution for 30 minutes to precipitate the formed flocs. After precipitation, the sample in a beaker glass is taken using a pipette. The sample taken was the supernatant, which was then carried out to the laboratory tests for the parameters of COD, TSS, and turbidity.

III. Results

Effect of Aloe vera Biocoagulant in Removal Efficiency of COD, TSS and Turbidity

In the initial test, it was found that the concentration of COD, TSS and turbidity in the palm oil industry's wastewater samples were 338.2 mg/L, 220.25 mg/L, and 20.25 NTU. In this discussion, it will be known the amount of reduction in COD (Chemical Oxygen Demand), TSS (Total Suspended Solids) and turbidity content in wastewater samples before and after applying *Aloe vera* biocoagulant.

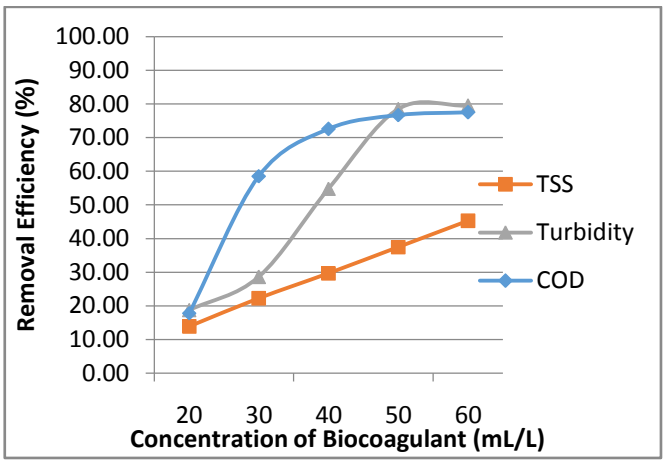

Figure 1. Removal Efficiency Graphic of *Aloe vera* Biocoagulant

Figure 1. shows that the higher concentration of aloe vera biocoagulant, the higher removal efficiency obtained. The maximum decrease in COD, TSS and turbidity occurs when the concentration of *Aloe vera* biocoagulant wass 60 mL/L. COD concentration decreased by 262.15 mg/L or by removal efficiency 77.51%. In addition, TSS concentrations decreased by 99.75 mg/L or by removal efficiency 45.29%, and turbidity concentrations decreased by 16.05 NTU or by removal efficiency 79.5%. At concentrations that exceed optimum concentration, turbidity will rise again. This is because at the optimum concentration, colloids had been neutralized and precipitated, so that excessive coagulant addition will cause the waste water became turbid again because it cannot interact with different charge of colloidal particles [5].

The optimum concentration of *Aloe vera* biocoagulant is 60 mL/L can bind pollutants in wastewater. Coagulant's dosage is an important factor that has been considered to determine the optimum conditions of coagulant in the coagulation-flocculation process. Excess or lack of dosage

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will cause unfavorable results in the coagulation-flocculation process [16].

Aloe vera contains *acetylated mannan* (*acemannan*) which is a polysaccharide. This *acetylated mannan* is capable of treating wastewater contaminants. Carbohydrate analysis shows that *Aloe vera* wall's cell has mannose containing polysaccharides. Many researchers have identified *acetylated mannan* (*acemannan*) as the main polysaccharide in *Aloe vera* gel. In general, mannans play a structural role in plants as hemicellulose which binds cellulose. Mannans also fulfill the storage function as a reserve of non-starch carbohydrates in seeds and vegetative tissue [7]. The *acetylated mannan* content in *Aloe vera* biocoagulant is 1.82%.

During the coagulation process, interactions occur between particles of different sizes, and form particles that are larger and faster to settle than small particles and also tend to collide further and join with other small particles until the coagulation process ends. The mechanism of coagulation and flocculation can be explained by the mechanism of charge neutralization and bridging (connecting several particles into floc particles). Mucilago is a mixture of high molecular weight polysaccharides. The increase in molecular weight of flocculants supports relative bridging to fill the neutralization mechanism. Bridging may be caused by the hydrophilic nature of the mucilago, some hydrogen bonds are formed between polyelectrolyte molecules and water. This association tends to occupy a larger surface area which causes very high viscosity. This is one of the characteristics of forming agglomerates/clods [3].

The Effect of Moringa oleifera Biocoagulants in Removal Efficiency of COD, TSS and Turbidity

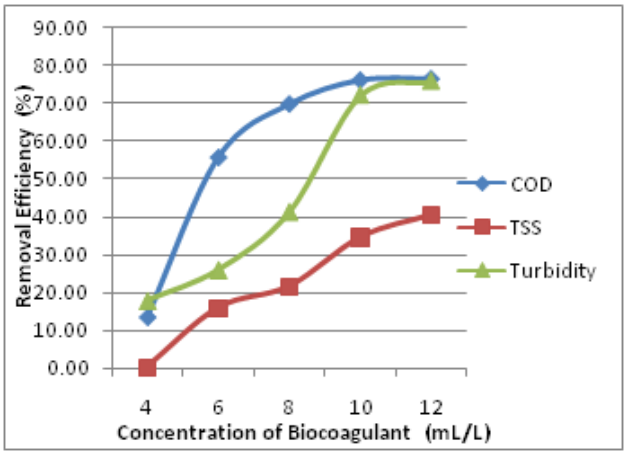

Figure 2.Removal Efficiency Graphic of Moringa Seeds Biocoagulant

Figure 2. shows that the higher concentration of moringa seed biocoagulants, the higher removal efficiency obtained. The maximum decrease in COD, TSS and turbidity occurred when the concentration of moringa seed biocoagulant was 12 mL/L. COD concentration decreased by 259.3 mg/L or by removal efficiency 76.67%. In addition, TSS concentrations decreased by 89.25 mg/L or by removal efficiency 40.52%, and turbidity concentrations decreased by 15.35 NTU or by removal efficiency 75.8%. At concentrations that exceed optimum concentration, turbidity will rise again. This is because at the optimum concentration, colloids had been neutralized and precipitated, so that excessive coagulant addition will cause the waste water become turbid again because it cannot interact with different particles charge of colloidal [5].

Coagulant dosage is an important factor that has been considered to determine the optimum conditions of coagulant in the coagulation-flocculation process. Excess or lack of dosage will cause unfavorable results in the coagulation-flocculation process [16].

Moringa seeds contain active substances in the form of *4-alpha-4-rhamnosyloxy-benzyl-isothiocyanate* which has function to absorb and neutralize the surface tension of the waste water particles [4]. When the moringa seed biocoagulants are added to the wastewater sample and fast stirring (coagulation), the cationic proteins found in the moringa seeds are distributed throughout the wastewater which then interacts with the negatively charged particles wich caused the dispersed turbidity. This interaction influences the force causing the stability of the particles to be disturbed, so that they can bind to small particulates to form sediment [5]. The content of *4-alpha-4-rhamnosyloxy-benzyl-isothiocyanate* in moringa seed biokoagulant is 3.01%.

The Effect of Mixed Aloe vera and Moringa oleifera Biocoagulants on Removal Efficiency of COD, TSS and Turbidity

Jar test was carried out with varying volume of affixing moringa seed biocoagulants, was 2 mL, 3 mL, 4 mL, 5 mL, and 6 mL. As for the affixing of a constant aloe vera biocoagulant 10 mL.

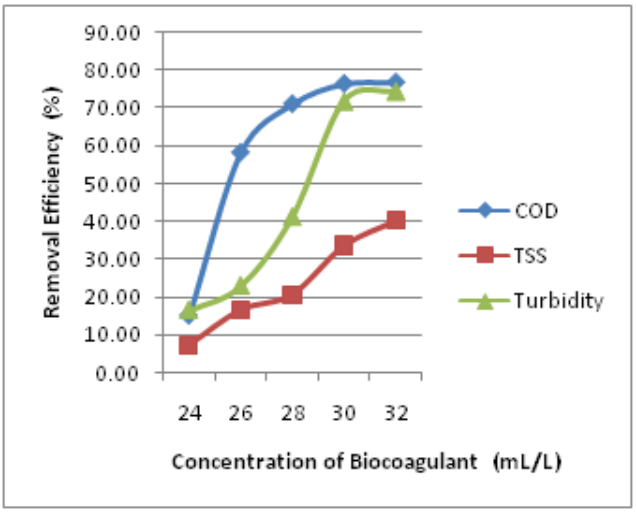

Figure 3.Removal Efficiency Graphic Mixed Biocoagulant of Moringa Seeds

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Figure 3. shows that the highest concentration of biocoagulant mixture of aloe vera and moringa seeds, more removal efficiency is obtained. The maximum decrease in COD, TSS and turbidity occurred when the biocoagulant concentration was 32 mL/L. The COD concentration decreased by 259.85 mg/L or by removal efficiency 76.83%. In addition, TSS concentrations decreased by 88.75 mg/L or by removal efficiency 40.3%, and turbidity concentrations decreased by 15.1 NTU or by removal efficiency 74.57%. At concentrations that exceed optimum concentration, turbidity will rise again. This is because at the optimum concentration, colloids had been neutralized and precipitated, so that excessive coagulant addition will cause the waste water become turbid again because it cannot interact with different particles charge of colloidal [5].

The aim of mixing *Aloe vera* and moringa seeds as biocoagulant is to improve biocoagulant performance in treating palm oil industry wastewater so that the removal efficiency will be higher than aloe vera biocoagulant and moringa seed biokoagulant. However, based on the results of the study it was found that the removal efficiency of *Aloe vera* biocoagulant was higher than the removal efficiency of aloe vera and moringa mixtures on treating palm oil industry wastewater.

IV. Results

The optimum concentration of Aloe vera 60 mL/L proved the removal efficiency of COD was 77,51%; TSS was 45,29%; and turbidity was 79,51%. Moreover, the optimum concentration of moringa seeds 12 mL/L proved the removal efficiency of COD was 70,67%; TSS was 40,52%; and turbidity was 75,8%. Whereas, the optimum concentration of mixed Aloe vera and moringa seeds is 32 mL/L proved the removal efficiency of COD was 76,83%; TSS was 40,3%; and turbidity was 74,57%.

V. References

[1] Altaher H and Alghamdi A 2011 Enchanment of Quality of Secondary Industrial Wastewater Effluent by Coagulation Process: A Case Study*Journal of Enviromental Protection.***2**1250-1256

[2] Amruta G and Munavalli G 2017 Use of Aloe Vera as Coagulant Aid in Turbidity Removal *International Journal of Engineering Research and Technology*. **10** 314-317

[3] Anuradha K, Bangal P, and Madhavendra SS 2012 Novel Natural Coagulants for Water Clarification *Environmental Science An Indian Journal*. **7** 226-232.

[4] Bangun AR, Aminah S, Hutahaean RA, and Ritonga MY 2013 Pengaruh Kadar Air, Dosis, dan Lama Pengendapan Koagulan Biji Kelor sebagai Alternatif Pengolahan Limbah Cair Industri Tahu. *Jurnal Teknik Kimia USU*. **2** 7-13.

[5] Bramantyo AE and Mustofa A 2014 Pembuatan Bio Koagulan dari Biji Kelor (Moringa Oleifera) sebagai Pengganti Koagulan Sintetis (Tawas) (Surabaya: Institut Teknologi Sepuluh Nopember)

[6] Bratby J 2016 *Coagulation and Flocculation in Water and Wastewater Treatment* (London: IWA Publishing)

[7] Hamman J H 2008 Composition and Applications of Aloe Vera Leaf Gel. *molecules***5** 1599-1616

[8] Idris J, Som A, Musa M and Hamid K 2013 Dragon Fruit Foliage Plant-based Coagulant for Treatment of Concentrated Latex Effluent: Comparison of Treatment With Ferric Sulfate. *Journal of Chemistry***2013** 1-7

[9] Irma NY, Philippe S, Abdoukarim A, Alassane YA, Pascal AC and Daouda, M 2016 Evaluation of Aloe Vera leaf gel as a Natural Flocculant: Phytochemical Screening and Turbidity Removal Trials of Water by Coagulation Flocculation *Research Journal of Recent Science***5** 9-15

[10] Jabarullah, N., Jermsittiparsert, K., Melnikov, P., Maseleno, A., Hosseinian, A., & Vessally, E. (2020). Methods for the Direct Synthesis of Thioesters from Aldehydes: A Focus Review. *Journal of Sulfur Chemistry*, *41*(1), 96-115.

[11] Jadhav M and Mahajan Y 2013 A Comparative Study of Natural Coagulants in Flocculation of Local Clay Suspensions of Varied Turbidities *Journal of Civil Engineering and Technology (JCIET)***1** 26-39

[12] Kristijarti AP, Suharto I and Marieanna 2013 Penentuan Jenis Koagulan dan Dosis Optimum untuk Meningkatkan Efisiensi Sedimentasi dalam Instalasi Pengolahan Air Limbah Pabrik Jamu X (Bandung:Universitas Katolik Parahyangan)

[13] Malaka D 2011 Kajian Efektifitas Tepung Biji Kelor dalam Meningkatkan Kualitas Air (Palu:Universitas Tadulako)

[14] Nurmalita, Maulidia and Syukri M 2013 Analisa Kekeruhan dan Kandungan Sedimen dan Kaitannya dengan Kondisi DAS Sungai Krueng Aceh. Seminar Nasional Pengelolaan Daerah Aliran Sungai Berbasis Masyarakat menuju Hutan Aceh Berkelanjutan (Banda Aceh: Universitas Syiah Kuala)

January - February 2020
ISSN: 0193-4120 Page No. 3435 - 3439

[15] Pichler T, Young K, and Alcantar N 2012 Eliminating Turbidity in Drinking Water Using the Mucilage of a Common Cactus. *Water Science & Technology: Water Supply***12.2** 179-186.

[16] Putra R, Lebu B, Munthe Dand Rambe A 2013 Pemanfaatan Biji Kelor Sebagai Koagulan pada Proses Koagulasi Limbah Cair Industri Tahu dengan Menggunakan Jar Test. *Jurnal Teknik Kimia USU***2** 28-31

[17] Radzuan RM, Mohamed, RMSR,Al-Gheethi A & Kassim AH 2017 Application of Natural Coagulants for Wastewater Treatment*Integrated Water Resources Protection***1** 60-73

[18] Yonas R, Irzandi U and Satriadi H 2012 Pengolahan Limbah POME (Palm Oil Mill Effluent) dengan Menggunakan Mikroalga*Jurnal Teknologi Kimia dan Industri***1** 7-13