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Efficiency in Reducing Turbidity and TSS (Total Suspended Solid) Level Using Biocoagulant of Tamarind Seeds by Adjusting Raw Water pH Ferry Kriswandana1(corresponding author), Abrelian Ari Ratmansyah2, Marlik3 1Department of Environmental Health, Poltekkes Kemenkes Surabaya, Indonesia; ferry.kesling@gmail.com 1Department of Environmental Health, Poltekkes Kemenkes Surabaya, Indonesia 1Department of Environmental Health, Poltekkes Kemenkes Surabaya, Indonesia; marlik_kesling@yahoo.co.id Submitted: June 12, 2020 -Revised: June 23, 2020 -Accepted: June 24, 2020 -Published: July 5, 2020 ABSTRACT Tamarind seeds can be used as coagulant because they contain protein that have role as polyelectrolytes. Optimum dose of tamarind seeds as

coagulant material to reduce turbidity and TSS level in raw water (river water) had been researched previously, which was 1000 mg / L without noticing more on pH of river water that was used during the coagulation process. Furthermore, the purpose of this study was in order to investigate differences in the efficiency of biocoagulant of tamarind seeds in dose of 1000 mg / l for reducing turbidity and TSS level in raw water based on pH treatment. This research was a pre-experimental research with one group pre -posttest design. Subjects in this research were tamarind seeds as coagulant, meanwhile, the object in this research was raw water of Jagir River. This research used three variations of treatment for pH conditions, which were: acidic (pH 4), neutral (pH 7), and alkaline (pH 10) with coagulant doses of tamarind seeds each treatment in 1000 mg / L. Each treatment was replicated 9 times. The data that was obtained in this research was examined by calculating the efficiency in reducing turbidity and TSS levels, paired t-test statistical test, one-way anava test, and probit test. Moreover, result of this research showed that the best efficiency in reducing turbidity and TSS level by using coagulant of tamarind seeds in dose of 1000 mg / l was by treating acidic conditions (pH = 4), thus, it resulted efficiency value in reducing turbidity and TSS level for 94.56% and 83.78%. Result of paired t-test showed that there was a significant difference in the average of turbidity and TSS level before and after treatment. Result of one-way anava test showed that there was a significant difference in the average of efficiency in reducing turbidity and TSS level between treatment of acidic condition (pH = 4) and neutral conditions (pH = 7) and alkaline conditions (pH = 10). Result of probit test showed expectation of efficiency in reducing turbidity and TSS level in 85% and it required optimum pH values in 4.268 (acid) and 3.417 (acid). All in all, old tamarind seeds could be used as tamarind seed powder. Thus, it could be used as a coagulant material in order to purify water that was more efficient relatively and eco friendly. Keywords: pH; coagulant, tamarind seeds; efficiency INTRODUCTION Raw water is water that qualifies the quality standards as raw material for either sanitary hygiene or drinking water. There are three types of raw water sources, which are surface water sources, groundwater sources, and rainwater sources(1). Various sources of raw water are surface water that is more easily accessible or easier in taking process. Surface water can be more easily accessible because the water condition is above the surface of the ground and it does not absorb into the ground. One example of the surface water is river water. Jagir River is raw water for making drinking water and clean water in Surabaya City. In physical quality side, Jagir River water is looked turbid and dirty. Result of laboratory test that was conducted by Surabaya Municipal Waterworks (Perusahaan Daerah Air Minum (PDAM)) in January-October 2019 also showed that turbidity and Total Suspended Solid (TSS) parameters of Jagir River water experienced fluctuation everyday, and majority of the data obtained result that it exceeded the quality standard and it could be said to be unqualified. Nevertheless, one of the ways to reduce turbidity and TSS parameter in raw water is through coagulation-flocculation process that is followed by sedimentation process. The coagulation-flocculation process certainly requires coagulant material. Coagulant is a synthetic material that is added in order to destabilize colloidal particles in raw water so that floc can be formed(2). Many coagulants are used in raw water treatment, which is classified into chemical coagulants and natural coagulants. One of the examples of chemical coagulant that is often used is aluminum sulfate. Ananda and Ismail (2016) explained that alum could be said to be less eco friendly because aluminum content in alum was categorized as heavy metal ions which could cause damage of detoxification tissue and liver and kidney excretion if it entered the human body continuously. Regarding high price of chemical coagulants and their less eco friendly properties, it is required a research about the use of natural coagulants

which are from certain plants or commonly as biocoagulant. Tamarind seeds can be used as natural coagulant (biocoagulant) because they contain proteins that have role as polyelectrolytes. The dissolved protein contains -NH3+ group, thus, it can bind to particles which are negative charge and the particles would be destabilized to form larger particles so that they could eventually be precipitated (3). Tamarind seed coat has tannin content in 20.2%. The starch content in tamarind seed flesh is 33.1%. Tannin that is contained in tamarind seeds functions as an active ingredient that causes coagulation process, while, natural polymer such as starch functions as flocculants(3). Wardani and Agung (2016) explained that optimum dose of coagulant of tamarind seeds for reducing turbidity and TSS level in river water was 1000 mg / L with reduction efficiency in 51.79% for turbidity parameter and 74.07% for TSS parameter(4). Result of the reduction efficiency could not be said to be optimum because the efficiency of reduction was still far below 85%. In this research, it had not been conducted optimum pH adjustment for biocoagulant of tamarind seed. Therefore, this research would improve the efficiency of biocoagulant by observing the effect of optimum pH during coagulation-flocculation process in using biocoagulant of tamarind seed. Furthermore, this research aimed at investigating the difference of efficiency for biocoagulant of tamarind seeds in reducing turbidity and TSS level in raw water based on providing tamarind seed powder in 1000 mg/l with variation of acidic pH (pH 4), neutral pH (pH 7), and alkaline pH (pH 10). Goal The purpose of this research is knowing the Efficiency of Tamarind Seed Biocoagulant in Reducing Turbidity and Levels of Tss (Total Suspended Solid) by Adjusting the pH of Raw Water. Hypothesis Tamarind Seed Biocoagulant is Effective in Reducing Turbidity and Levels of Tss (Total Suspended Solid) by Adjusting the pH of Raw Water. METHODS The type and design of this research was pre-experimental research with one group pre-post test design. The subject of this research was tamarind seeds as a coagulant, while the object of research was the raw water of Jagir River. The treatment group in this study used 1000 mg / l tamarind seed powder with variations in the pH value of acidic raw water (pH 4), neutral pH (pH 7), and alkaline pH (pH 10), and each variation was carried out nine replication. The data analysis of this study used the calculation of efficiency in reducing turbidity and TSS, the statistical test used was the paired t-test, one-way ANOVA, and the probit rate of error that was applied was α<0.05. RESULTS Measurement result of turbidity level in raw water before being provided 1000 mg / l of tamarind seed coagulant was 357 NTU, while, for each average of turbidity level samples which were treated with acidic pH (4), neutral pH (7), and alkaline pH (10) were 19.43 NTU, 198.54 NTU, and 206 NTU. Measurement results of TSS level in raw water before being provided by coagulant of tamarind seed powder in 1000 mg/l were 200 mg/l, whereas, for each TSS level, the sample variation of acidic pH (4), neutral pH (7), and alkaline pH (10) were 32.44 mg / l, 111.71 mg / l, and 138.33 mg / l. Standard deviation for the measurement of turbidity and TSS levels in variations of acidic pH (4), neutral pH (7), and basic pH (10) were 2.52; 68.71; 77.36 and 6.69; 14.99; 45.08. The results in table 1 show that the average efficiency of reducing the turbidity level in raw water for sample variations in the treatment of acidic pH (4), neutral pH (7), and alkaline (10) is 94.56%, 44.39%, and 42.30%. The average efficiency of reducing TSS levels in raw water for samples of variations in acidic pH (4), neutral pH (7), and alkaline pH (10) was 83.78%, 44.14%, and 30.83%. Table 1. Efficiency in reducing turbidity and TSS Turbidity TSS Replication pH 4 (%) pH 7 (%) pH 10 (%) pH 4 (%) pH 7 (%) pH 10 (%) 1. 95.10 61.06 35.85 86.8 53.8 49.1 2. 95.24 16.25 66.95 86.8 40.6 48.1 3. 94.40 38.10 67.51 86.8 43.4 48.1 4. 95.10 40.90 62.46 79.3 42.5 45.3 5. 95.27 72.07 59.10 86.8 54.7 47.2 6. 94.31 70.87 16.81 84 51.9 0 7. 94.26 31.09 15.69 84 38.7 0 8. 94.26 36.08 31.65 79.3 34.9 35.9 9. 93.08 33.05 24.65 80.2 36.8 3.8 Average 94.56 44.39 42.30 83.78 44.14

30.83 Minimum 93.08 16.25 15.69 79.3 34.9 0 Maximum 95.27 72.07 67.51 86.8 54.7 49.1 The results of the paired t-test for both the turbidity level and TSS level showed that there was a significant difference in the average before and after being given a coagulant of 1000 mg / l tamarind seeds both at acidic raw water pH (4), neutral. raw water (7), and alkaline raw water (10) (P <0.05). The one-way Anava test results show that there is a significant difference in the average efficiency of decreasing turbidity and TSS levels in acidic raw water pH (4), neutral raw water (7), and alkaline raw water (10) (P <0.05). While the results of the probit test show a probability value of 0.850 (85%) so that the estimation results are 4.268 for the turbidity parameter and 3.417 for the TSS parameter. DISCUSSION Quddus (2014) explains that turbidity is an optical effect that occurs when light forms suspended material in water so that it shows the level of clarity in water(8). Total Suspended Solid (TSS) is the concentration value of organic and inorganic compounds and solids suspended in water(9). Analysis result of water samples after being provided by coagulant (tamarind seed powder in 1000 mg / l) with variation of acidic pH (pH 4), neutral pH (pH 7), and alkaline pH (pH 10) showed that it was occurred a reduction of turbidity parameters which were 19.43 NTU, 198.54 NTU, and 206 NTU. Quality standard (maximum level) that was allowed for turbidity parameter in water for sanitation hygiene requirements according to Regulation of Minister of Health (Permenkes) Number 32 of 2017 was 25 NTU. However, this research recommended for raw water treatment to use these coagulants in reducing turbidity level in which pH of the water must be in acidic condition (pH = 4). Analysis result of water samples after being provided coagulant (tamarind seed powder in 1000 mg / l) with variation in acidic pH (pH 4), neutral pH (pH 7), and alkaline pH (pH 10) showed that it was occurred a reduction in TSS parameters, which were 32.44 mg / l, 111.71 mg / l, and 138.33 mg / l. Meanwhile, quality standard of river water according to Government Regulation Number 82 of 2001 stated that the quality of river water, which functioned as raw water of clean water, the maximum TSS level that was allowed was 50 mg / l. Therefore, this research recommended for raw water treatment to use these coagulants in reducing TSS level, which the pH of the water must be in acidic condition (pH = 4). The efficiency in reducing turbidity and TSS levels in this research showed that by conditioning into acidic pH (pH = 4) in water treatment through using coagulant, the efficiency of reduction was achieved more than 80% and it had qualified the water quality standards / requirements as what was intended. pH is the degree of acidity of a liquid, the coagulation process is strongly influenced by pH. Coagulant material has a certain pH range to work optimally(10) . For each type of coagulant, the optimum pH is different from each other (11) . Paired t-test result showed that there was a significant difference of average between turbidity level and TSS level before and after being provided by tamarind seed powder in 1000 mg / l through adjusting pH of raw water. The differences in the average certainly showed that the average of turbidity level and TSS level after being provided by tamarind seed powder in 1000 mg / l was lower if it was compared to the average of turbidity level and TSS before being provided by tamarind seed powder in 1000 mg / l. Fitriani (2016) explained that tamarind seeds contained protein compounds, tannins, carbohydrates, calcium, ash content, fat, fiber, lenoleic acid, oleic acid and phosphorus (3). Besides, tamarind seeds could be used as natural coagulants because they contained protein. Protein content in tamarind seeds that was dissolved in water changed into positive electrolytes that could destabilize the substances which caused turbidity and suspended solid that was negatively charged. Thus, these substances could be precipitated through the gravity (sedimentation process). By precipitating these substances, the light barrier substances that entered into the water reduced and finally, the water could be looked clearer and the total of suspended solid level would

be reduced too. As we know that water treatment process uses coagulation method. Basically, there are three sequences of processes that cannot be separated and changed the sequences. The first is coagulation process, second is flocculation process, and third is sedimentation process. Coagulation process is a process of mixing coagulant material by rapid stirring in order to destabilize colloids and delicate suspended solids, thus, it will form micro floc. Flocculation process is a process of slow stirring against solution that has been processed in coagulation process so that the microfloc that is produced during coagulation process can form floc with larger size. Thus, the flocs can be precipitated through sedimentation process (5). Analysis result of the difference in average of efficiency in reducing turbidity level of raw water showed the difference in the average of efficiency in reducing turbidity levels with pH variations. The difference showed that the average of efficiency in reducing turbidity levels with acidic pH treatment was higher rather than by using either neutral pH treatment or alkaline pH treatment. This showed that optimum pH for coagulant of tamarind seeds was by using acidic pH. Hayati (2015) explained that protein contained amine group and carboxyl group. In alkaline condition, the carboxyl group (COOH) would deprotonate to form negative charge (COO-) and it caused loss of active side in coagulant [4]. In acidic condition, the amine group (-NH2) would be protonated to ionic -NH3+. These ions which functioned to destabilize suspended solids and colloids caused turbidity in water. Furthermore, it was in line with this research result which showed that in acidic pH condition, the coagulant of tamarind seeds would function more optimally in binding colloids and suspended particles in water. Meanwhile, analysis results for the difference in the average of efficiency in reducing TSS level in raw water showed that the average of efficiency in reducing TSS level through the variation in acidic pH treatment was higher. This could be interpreted that optimum pH for coagulant of tamarind seeds was acidic pH. Hayati (2015) explained that the higher the pH, the lower the amount of organic substance that was absorbed by coagulant of tamarind seeds. In low pH of amine group that was contained in tamarind seed protein would be protonated to NH3+ as active side of coagulant (4). The higher the concentration of H+ in solution, it would increase the active side of tamarind seeds. Thus, the lower the pH, the more improvement for the ability of tamarind seeds in reducing organic substance. In addition, probit test results showed that in order to reduce turbidity and TSS level through expectation of efficiency of reduction in 85% by using coagulant of tamarind seeds in dose of 1000 mg / l, optimum pH in 4268 (turbidity) and optimum pH in 3,417 (TSS) were required. Hayati (2015) explained that tamarind seeds contained protein compounds (4). Protein contained amine groups. Amine group (-NH2) in low pH would be protonated to be -NH3+ as an active coagulant that could bind negative groups in raw water so the colloidal stabilization was occurred. Wismaningtyas (2019) explained that reducing colloidal stability would reduce repulsive force between particles, hence, it could improve sedimentation process (5). CONCLUSION The conclusion of this study proves that tamarind seeds can be used as an alternative to natural coagulants to reduce turbidity parameters and the TSS of raw water. Tamarind seeds as a natural coagulant in acidic conditions (pH = 4) are more optimal in reducing turbidity and TSS levels in water. There was a significant difference in the mean turbidity and TSS levels before and after giving tamarind seed powder 1000 mg / l at variations in pH 4, 7, and 10. There was a significant difference in the average efficiency in reducing turbidity and TSS levels between acid pH (4), pH treatments neutral (7), and alkaline pH (10). The hope of efficiency in reducing turbidity and TSS levels at 85% using tamarind seed coagulant dose of 1000mg / l is at an optimum pH of 4.268 (acid) for turbidity parameters and an optimum pH of 3.417 (acid) for TSS parameters. REFERENCES 1. Yudo S, Said NI. Surabaya River Water Quality Conditions (Kondisi

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