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To cite this article: Elida Novita *et al* 2019 *IOP Conf. Ser.: Earth Environ. Sci.* **347** 012019

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Moringa Seeds (*Moringa olifera* L.) Application as Natural Coagulant in Coffee Wastewater Treatment

Elida Novita¹, Sri Wahyuningsih¹, Hendra Andiananta Pradana², Wendy Dreifyana Marsut¹, Akhmad Farisul F¹

¹Department of Agriculture Engineering, Jember University, Jalan Kalimantan 37, Jember, 68121, Indonesia. E-mail: elida_novita.ftp@unej.ac.id

²Master Program of Water Resources Management – Postgraduate Program, Jember University, Jalan Kalimantan 37, Jember, 68121, Indonesia. E-mail: hendraandiantapradana@gmail.com

Abstract. The coffee processing will produce a wastewater with a low pH. It is corrosive and dangerous for the environment. One of the alternative solution to solve this problem is by applying the coagulation- flocculation treatment. The natural coagulant that can be applied is the moringa seeds powder. The aim of this research is to optimize the coagulation – flocculation treatment by using mesh variation moringa seed powder in coffee wastewater pollution decreasing. Experimental design used a completely randomized design (CRD) to dosage the optimization based on mesh size variation in moringa seed powder with rind and rindless toward coffee wastewater pollution decreasing. Duncan assay showed that with $\alpha \leq 0.05$, mesh size variation in moringa seed powder with rind and rindless was significantly different. The best treatment in coagulation – flocculation using moringa seed as nature coagulant was rindless moringa seed powder. The optimal particle size was 60 mesh due for having a little efficiency level with 70 mesh and 80 mesh and it is easier than the manual one. It has the efficiency level decreasing in TSS, turbidity and COD of 60 mesh was $69.44 \pm 1\%$; $88.15 \pm 0.5 \%$ and $41.80 \pm 0.5 \%$.

1. Introduction

Indonesia is a country that classified into the top 5 largest coffee producer in the world. Coffee is one of the leading seeds of the plantation sector in Indonesia. In general, there are two methods used to make dry and wet coffee processing. Wet processing of coffee beans result good quality coffee seeds but not environmental friendly. It requires a lot of water. According in reference [1, 16] wet water processing needs of 7 - 9 m³ per ton of processed coffee fruit, as according to Ref. [2, 8] needs water of 5 - 6 m³ per ton of processed coffee fruit and 10 - 30 m³ per ton of coffeein [3,7]. Effluent from wet coffee bean processing is coffee wastewater.

The coffee wastewater has pH of 4,0– 5.0, so it is corrosive and can disrupt organism life and pollute the water source [4,9]. Alternative for coffee wastewater treatment is coagulation - flocculation. Coagulation is a process of water treatment or liquid waste by stabilizing colloidal and suspended solid particles in which bacteria and viruses are produced by compression of a double layer that is electrically charged and surrounds the particle surface whereas flocculation is a process of water treatment by way of contact between the colloidal particles that have been destabilized so that the size of the particles becomes larger [5, 2].

Moringa seeds as natural coagulant created from moringa (drumstick tree) seed pods. The moringa seeds can reduce the pollutant content with the efficiency value of turbidity , TSS and COD



was 77.4%, 90% and 63% respectively in samples in the form of tofu wastewater dose of moringa seeds as much as 5 grams / 200 mL [6, 1]. The moringa seeds used in the study were moringa seeds that had been separated from their skin and conditioned in size to 70 mesh while the coagulation research using 30 mesh leaf moringa seeds performed by [7, 10], using mocafwastewater had a decreased efficiency value turbidity, Total Solid Suspended (TSS) and Chemical Oxygen Demand (COD) sequentially was 59.79%, 75.46% and 32.55% with moringa dose of 850 mg / l.

Optimum dose of moringa seeds with rind and rindless needs to be done on coffee wastewater treatment. The effort is made to obtain the most effective coagulation - flocculation alternative in wastewater treatment using natural coagulant.

The purpose of this research was the optimization of coagulation process - flocculation based on variation of dose of moringa seeds with rind and rindless in the coffee wastewater treatment.

2. Method

2.1. Tools and Materials

The tool used in this research is water jerry can volume 30 liter, health test H - FL - 6 flocculator, pH meter calibration check HI 223, analytical balance OHAUS, 500 mL and 1000 mL beaker glass pyrex, turbidity meter TN - 100, stopwatch, (60, 70, 80, 100, 120 and 140 mesh), aluminum plate, 0.45 μ m filter paper, mortar, oven in memmert brand, HI 839800 COD reactor Hanna brand, Hanna HI 83099 spectra and plastic shelf. The materials used for the research was coffee wastewater with characteristics in Table 1. Moringa oleifera L. in Figure 1. aqua distillation, COD High Range (HR) HI 93754 C - 25, NaOH 1 M and H₂SO₄ 1 M.

Tabel 1. Coffee Wastewater Characteristic

Characteristic	Standard Quality	Value range
pH	6 – 9	4.5 – 5.1
TSS (mg/L)	100	127 – 140
Turbidity (NTU)	-	395 – 448
COD (mg/L)	200	3360 – 3762



Figure 1. Moringa seed (a) with rind and (b) rindless

2.2. Moringa Seed Powder Created

Moringa seeds in this case is the seeds kelor that is ripe and dry in the tree. Moringa seeds were removed from husk patch. Moringa seeds then put into the oven for 24 hours at 105 °C to reduce the water content to reach $\leq 10\%$. Finishing was done manually on the moringa seed with rind and rindless. Moringaseed sieving is done using 60, 70, 80, 100, 120 and 140 mesh.

2.3. Optimization of Speed Stirring

Determination of optimum stirring was a preliminary study aimed to find out how many rounds (rpm) needed for the coagulation - flocculation process. The method of determining optimum stirring speed was trial and error with stirring speed of 300 rpm, 400 rpm and 500 rpm. The optimal stirring density was known to be the highest level of turbidity decrease in coffee wastewater. Based on preliminary research the optimum velocity that will be used in coagulation is 400 rpm for 1 minute and flocculation speed 150 rpm for 15 minutes.

2.4. pH Optimization

Coffee wastewater has a low pH that will occurred collisions between particles that cause the formation of the petite flocculation and coagulation - flocculation is not effective. Therefore, it is necessary to determine the optimal pH of coagulation - flocculation. The preparation of the pH range was carried out by the addition of 1 M NaOH and H₂SO₄ to pH 4, 5, 6, 7, 8 and 9 in the coffee wastewater [7]. Beaker glass containing the waste is given a coagulant from moringa seed 60 mesh size as much as 850 ppm then coagulation - flocculation [8]. Coagulation was performed at 400 rpm stirring speed for 1 minute and flocculation at 150 rpm for 15 minutes. Then the deposition is done for 1 hour. The experimental results show that the optimum pH for the process is 9.

2.5. Coagulation – Flocculation Using Moringa Seed Powder with Rind

There were stages in determining the proper dose of liquid waste water treatment. Preparation of 6 beaker glass filled with 500 mL of coffee wastewater. The addition of maize seed coagulant size 60 mesh with a range of 4000 ppm (A1), 6000 ppm (A2), 8000 ppm (A3), 10,000 ppm (A4), 12,000 ppm (A5) and 14,000 ppm (A6) on each beaker glass at the optimum pH obtained was 9. Coagulation was performed using 400 rpm rotation speed and flocculation at 150 rpm for 15 minutes then precipitated for 60 minutes and measured turbidity in clear liquid. This experiment yielded an optimum dose of 3000 ppm.

Coagulation experiment - flocculation of coffee wastewater using moringa seed powder 100 mesh, 120 mesh and 140 mesh using dose 3000 ppm as preliminary research. The smaller the size of moringa seed particles, the decrease of turbidity, TSS and COD is greater and the decrease reaches 90% [6].

2.6. Dose Optimization of Moringa Coagulant with Rind and Rindless

Determination of coagulant dose was done to determine the proper dose on the coffee wastewater. There were 3 stages of optimal dose determination. First, the preparation of 6 pieces of beaker glass filled with 500 mL of coffee wastewater. Second, coagulant addition of 4000 ppm (B1), 6000 ppm (B2), 8000 ppm (B3), 10,000 ppm (B4), 12,000 ppm (B5) and 14,000 ppm (B6) in each beaker glass at optimum pH obtained by 9. The third, coagulation using the optimum rotation speed and coagulation process at 400 rpm for 1 minute and flocculation 150 rpm for 15 minutes then precipitated for 1 hour and measured turbidity in clear liquid. The experiments performed resulted in an optimum dose of 6000 ppm.

2.7. Coagulation and Flocculation on Coffee Wastewater Using Mesh Variation

This research was conducted to know the difference of moringa seed treatment with and rindless and particle size on the decrease of pH, turbidity, TSS and COD of coffee wastewater. There were 4 stages of research. First, the preparation of 9 pieces of beaker glass which were divided into three series that filled 500 mL of coffee wastewater. Each beaker glass was determined pH using NaOH until reaching 9 second, the beaker glass series given the same coagulant dose in accordance with the results of the optimum dose measurement that has been obtained was 6000 ppm but with the size of the different moringa seeds were three beaker glass filled with size 60, 70 and 80 mesh. It were had three replication respectively. Third, stirring was done simultaneously on 3 samples for repetition. Coagulation process using rotation (rpm) which has been obtained is coagulation rotation speed 400 rpm for 1 minute and flocculation process with speed 150 rpm for 15 minutes with process which can be seen in Figure 2. Fourth, after coagulation-flocculation process is done, we moved onto coffee

wastewater for 1 hour. After settling is complete, measurements of pH, turbidity, TSS and COD parameters are performed on clear fluid.



Figure 2. Dose optimization using jarstes

2.8. Experimental Design

The research was conducted using experimental or experimental methods. Completely Randomized Design (CRD) was an experimental method used. The purpose of this method was to know the difference in the moringa seeds powder with and rindless on variations in particle size to coffee wastewater treatment. This research used 6 treatments and each treatment was done 3 replication experiments. Experimental variables in this research have 2 that is surface condition of seed and particle size. The experimental design can be seen in Table 2.

2.9. Statistical Analysis

Data processing obtained in this research was processed by using program SPSS version 16 Analysis of Variances (ANOVA) test. It was used to know difference of treatments combination difference. The final result of ANOVA test is stated at F arithmetic. If F arithmetic is bigger or smaller compared to F table at degrees free with error rate of 0.01 (1%) or 0.05 (5%) it can be determined to reject or accepted the H0. The hypotheses tested in ANOVA were:

H0 : There was no significant difference between the various treatments of moringa seeds on the observation parameters.

H1 : There was a significant difference between various treatment of moringa on observation parameter.

Duncan test is done to compare the effect of treatment with the number of samples by looking at the value of P (sig), if the result is less than 0.05 then the difference is significant and if more than 0.05 then not significantly different.

Table 2. Variable And Experimental Parameters

Experimental Variable	Treatment	Code	Parameters
Seeds Condision	With rind	K1	pH
	Rindless	K2	Turbidity
Particles Size	60 mesh	P1	TSS
	70 mesh	P2	COD
	80 mesh	P3	

Treatment Combination:

K1P1 :Moringa seeds with rind 60 mesh

K1P2 :Moringa seeds with rind 70 mesh

K1P3 :Moringa seeds with rind 80 mesh

K2P1 :Rindlessmoringa seeds 60 mesh

K2P2 :Rindlessmoringa seeds 70 mesh

K2P3 :Rindlessmoringa seeds 80 mesh

2.10. Efficiency Measurement of Decreasing Pollution

Efficiency identification of decreasing level pollution on coffee wastewater used equation of efficiency decrease which can be seen in equation 1.

$$Eff = \frac{C_2 - C_1}{C_1} \times 100 \% \quad (1)$$

3. Result and Discussion

3.1. Coagulation – Flocculation Using Moringa Powder with Rind

Based on the research that pH increased after coagulation – flocculation. The final value of turbidity in 3 types of seed powder sizes was 396.33 mg/L, 340.33 mg/L and 396.33 mg/L with an initial coffee wastewater value of turbidity at 197 mg/L. The final value of TDS was 541.33 mg/L, 536.33 mg/L and 534.33 mg/L with the initial value of coffee wastewater TDS 339 mg/L. COD final values were 3394 mg/L, 3007 mg/L and 3161 mg/L with an initial COD 2589 mg/L. Graph of coagulation efficiency value - flocculation using moringa seed powder measuring 100 mesh, 120 mesh and 140 mesh with skin can be seen in Fig 3.

The increase of these three parameters, caused by the use of coagulant moringa seed has saturated so that the absorption process was not maximal. The content of the active substance on moringa seed particles (4 - alpha - 4 rhamnosyloxy - benzilisothiochinane) is not on the surface of moringa seeds, it is possible to denature moringa seed powder during the drying [9]. While the pH value decreased with the value of 6, 6.4 and 6.4 of the initial pH value of waste 9. The decrease in value due to moringa seed contains carboxyl groups of amino acid glutamate which interact with the coffee wastewater so that the pH becomes decreased (acid) [10]. This preliminary study showed that the smaller-sized crusted dusts were ineffective in coagulation - flocculation of coffee wastewater. Therefore, the size of moringa seed powder particles in subsequent studies using a smaller mesh. Particle size used for moringa seed with rind that is 60 mesh, 70 mesh and 80 mesh.

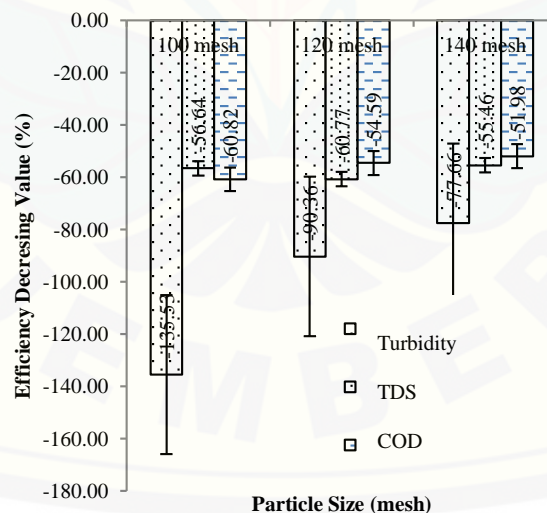


Figure 3. Efficiency value using moringa seed with rind

3.2. Comparison of Moringa Seed Powder with Rind and Rindless

3.2.1. pH Analysis

pH is the level of acidity and is an abbreviation of puissance de H [11]. The degree of acidity or pH indicated concentration ions (in moles per liter) in a certain temperature. The data in graphical form can be seen in Figure 4.

The initial pH value of the coffee wastewater at all treatments is using the optimum pH of 9. The pH value of the crude coconut seeds decreases sequentially on the particle sizes 60, 70 and 80 was 7.1; 6.8 and 6.9 whereas for the treatment of rindless moringa seeds has a pH value of 8.0; 8.0 and 8.1 which can be seen in Figure 4.

Coagulant application of moringa with and rindless gave different pH values for each treatment. Moringa with rind as coagulants can maintain pH values under alkaline conditions whereas the coagulant of moringa rind has a pH value that tends to be neutral. This difference is due to moringa seeds have a lower ability of buffer ability than leaf-free mutton. This is because the moringa seeds have rind that becomes insoluble fiber that can inhibit the performance of moringa seed as natural coagulant.

The effect of coagulant on the decrease of water pH is not significant that the maximum decrease is only 15% whereas, the coagulation process using moringa seeds gives little effect to the degree of acidity and conductivity [5]. When compared with the two statements, the pH value in this study has the similarity of the results of the study with previous research because the pH value drops in each treatment is only about 15%.

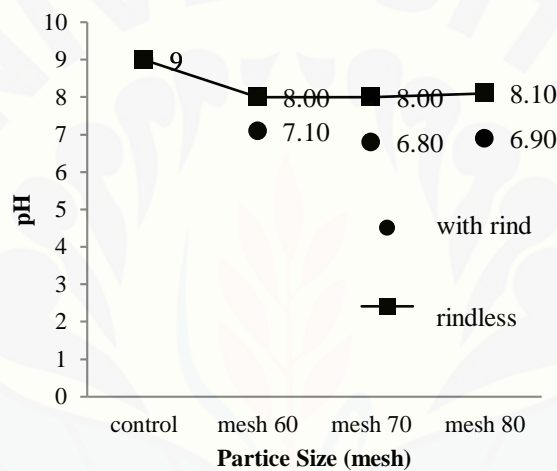


Figure 4. pH value comparison

3.2.2. Turbidity Analysis

Turbidity in water is generally caused by material suspensions such as soil, mud, organic and inorganic substances, plankton and other fine substances (microorganisms). The high value of turbidity can also complicate the screening efforts and reduce the effectiveness of disinfection in the water purification process [12]. The data in graphical form is shown in Fig 5.

Both treatments have a varied influence on decreasing the turbidity value. Treatment of moringa seeds on various particle sizes had an initial turbidity value of 448 NTU but the turbidity value jumped higher to 647.67 on 60 mesh particles size then dropped back to 425.67 NTU on 70 mesh particle sizes and decreased in size 80 mesh particles to 98.07 NTU. Treatment of rindless moringa seeds at various particle sizes has a lower turbidity value compared to the initial turbidity value of the effluent. The initial turbidity effluent originally valued at 394.5 NTU decreased to 52.93 NTU on 60 mesh particle size then further decreased to 49.57 NTU on the treatment of 70 mesh particles size and 38.70 NTU on a visible 80 mesh particles size on the graph in Figure 5.

The higher turbidity values in the use of moringa seeds are due to moringa particles used as coagulants containing more rind. The smoothed rind has a low protein value and insoluble fiber in water so that small grains of moringa seed used as a coagulant cannot absorb the anion of coffee wastewater so that turbidity increases [13]. The rind has a small protein content that is most likely to have denaturation due to direct warming during diesel. The denatured protein is no longer able to tug at colloidal of coffee wastewater because the cations on the rind are getting smaller. Based on the particle size in the two treatment combinations, it can be seen that the larger the mesh size of the

particles used, the smaller the turbidity value. Although the treatment of covered moringa seeds turbidity value is still high, but the turbidity value is decreased when the mesh size is used. This also occurs in the treatment of rindless moringa seed.

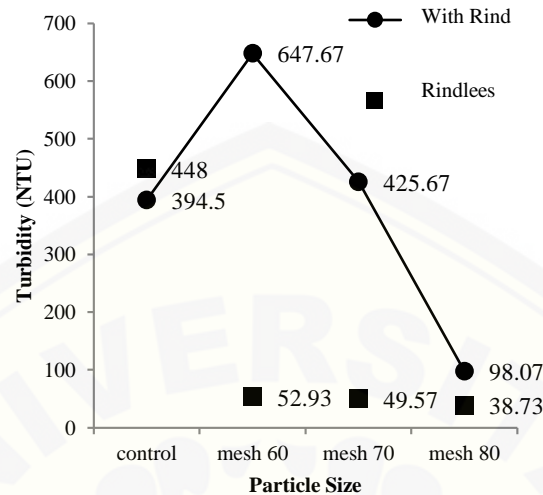


Figure 5. Comparison of turbidity

The value of turbidity on the treatment of rindless moringa seeds has excellent results. The turbidity value decreases with the increasing mesh. The smaller the particle size the surface area of the particle will be greater so that the active substances on the moringa seed is getting bigger and can work more effectively. The smaller (fine) the size of the coagulant particles of moringa seeds, the decrease of river water turbidity also tend to increase [11]. This is because if the smaller the size of the coagulant material particles, then the suspension has a large surface area so that the ion absorption space will be more widespread as well.

3.2.3. TSS Analysis

TSS in coffee wastewater comprises fine particles of the former pulping process and mucus-shaped organic particles [15]. TSS is a solid that cannot escape from 0.45 μm porous filtration paper. Suspended solids contained in the liquid waste include a mixture of various substances such as organic and inorganic materials. Organic substances that are suspended substances consist of various types of compounds such as glucose and pectin that float in water or can also be microorganisms such as bacteria, algae, and so on. The comparative graph of TSS values in both treatments can be seen in Figure 6.

Initial TSS for moringa powder with of 126.79 mg / l until 189.7 mg / l on 60 mesh particle size, then decreased to 134.45 mg / l on 70 mesh particle size and continued to decrease to 57.38 mg / l on the particle size of 80 mesh. Initial TSS values for skinless moringa of 139.95 mg / l decreased in all particle sizes. The TSS value at 60 mesh particle size decreased to 42.67 mg / l, then decreased to 41.93 mg / l on 70 mesh particle size and continued to decrease to 39.27 mg / l at 80 mesh. Change of TSS value can be seen in Figure 5.

The TSS values obtained from the two treatment combinations have met the standard value for TSS of 100 mg / l, for the exception in the combination of the treatment of moored coconut seeds on the particle size of 60 and 70 mesh. The decrease of TSS value on the treatment of skinless moringa seeds is effective because a coagulant is effective when the TSS decrease reaches 50% [6]. So it can be said that the elimination of TSS on the treatment of rindless moringa seeds has been effective because it can set aside TSS up to 50%.

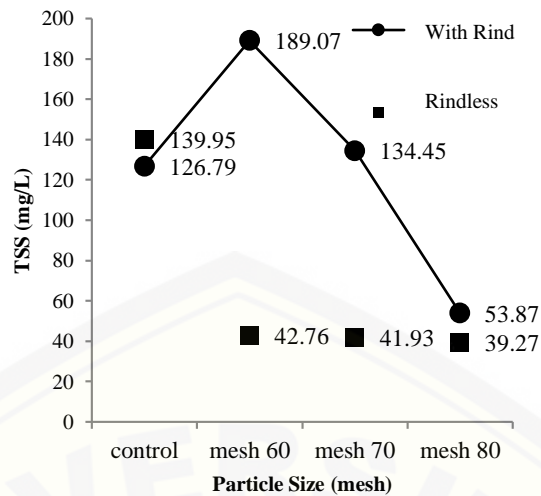


Figure 6. Comparison of TSS

TSS value obtained will affect the turbidity of coffee wastewater, the higher the TSS the higher turbidity is. This is due to the tyndall effect caused by the presence of TSS thus blocking the rays that will penetrate the suspension [16]. The TSS value on treatment using moringa seeds with rind on 60 mesh particle size is increasingly due to moringa seed particles that cannot join the coffee wastewater particles due to the large particle size and the absence of cations that can generate negative attraction (anions) in coffee wastewater [17]. Although the doses are given the same, the coagulant content of the skin-rinded moringa contains more skin. The active substance in moringa (4-alpha-rhamnosyloxyl-benzyl isothiochinane) cannot be on the surface of the moringa seeds so the coagulant works less effectively than the skinless treatment.

Moringa seed with rind becomes a drifting solid and difficult to precipitate with deposition time for 1 hour because of its light weight so it takes longer to get down to the bottom of the beaker glass. The post-coagulation deposition process of flocculation takes at least 1 to 3 hours the drifting solids cannot react with coffee wastewater because the active substances in the moringa seeds that function as a disinfectant are found only in the seeds of the moringa of the inside only makes the turbidity value higher [18].

3.2.4. COD Analysis

The initial COD of the coffee wastewater used in this research was between 3360 - 3762 mg/L. The first wastewater of 3360 mg/L was derived from the pulping process, the washing of coffee fruit and the washing of post-fermentation while the second liquid waste had a COD value of 3762 mg/l from the washing of coffee fruit and the peeling of the coffee fruit (pulping). Comparison data of COD value after treatment can be seen in Figure 7.

The effluent COD from coffee wastewater treatment was 3360 mg/L higher to 3626.67 mg/L at 60 mesh particle size. The value then becomes 3040 mg/L on a particle size of 70 mesh; and 3493.33 mg/l on a particle size of 80 mesh. The initial effluent COD value for treatment of rindless moringa of 3762 mg/L decreased to 2189.67 mg/L for treatment of 60 mesh particles size and then decreased to 1887.33 mg/L on 70 mesh particles size and rose again to 2243.33 mg/L at 80 mesh particle size.

Moringa seeds from both of these treatments were less effective in COD removal because the reduction in COD levels was not up to 50%. In addition, COD results from treatment using moringa seeds with rind had a value greater than the initial COD wastewater value at a combination of 60 mesh particle size treatment. This is because the rind of moringa seeds cannot work effectively in reducing organic matter due to coagulant particles that contain protein and antimicrobial active substance possibly covered by smoothed rind from moringa seed.

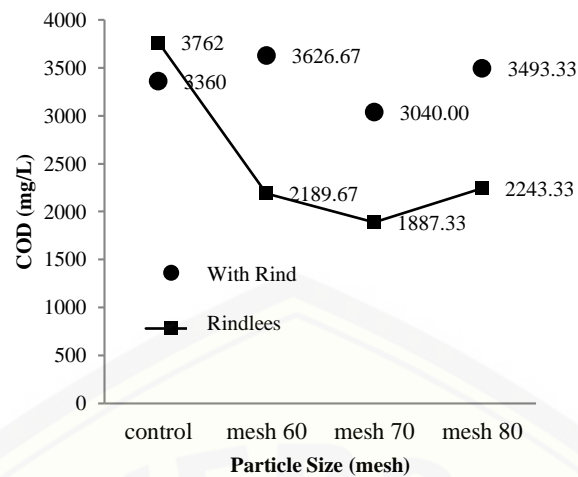


Figure 7. Comparison of COD

The results of COD on the treatment of moringa seeds with rind in particle size of 70 and 80 mesh decreased although only slightly as did the COD yield on the treatment of rindless moringa seeds with particle size of 60, 70 and 80 mesh which only slightly decreased. The fluctuation of COD values can be seen in the graph in figure 6. This is because the cationic polymer can reduce the organic matter content. Colloidal particles derived from organic matter have a negative electrical charge. The addition of a cationic polymer of rindless moringa seeds to colloidal particles with this negative charge will form a particle bridge between colloidal particles. The bridge of these particles will be interconnected with each other so that a sufficient mass is obtained to settle. With the settling of organic matter, the COD value will decrease. Decrease in COD is also due to antimicrobial properties owned by moringa seeds. The gram-negative and negative bacteria can be fluctuated by the protein present in the moringa seed [17].

The COD results obtained after the coagulation process is still above the threshold or the intended quality standard is 100 mg/l. COD obtained from the coagulation process still cannot meet the standard or standard quality that has been set. This is because too much organic and inorganic contained in the coffee wastewater. Coagulation is the primary for wastewater treatment [18]. The purpose is to remove suspended solids in water so that to be able to put aside high COD content in the waste is required further processing of secondary treatment which aims to eliminate the organic material in the waste. However, it does not mean that the coagulation process cannot exclude COD levels, the coagulation process can still eliminate the COD content of wastewater but secondary treatment required to eliminate the greater COD content. This may be due to several factors such as a relatively short settling time.

3.2.5. Duncan Test Result

Duncan test is done to compare the effect of treatment with the number of samples by looking at the value of P (sig), if the result is less than 0.05 then the difference is real and if more than 0.05 then not significantly different. The alphabets present in each treatment on the Duncan test show the same middle values and any mean unequal middle values. The post hoc tests using the Duncan method can be described in Table 3.

Table 3 shows that the values of each parameter of pH, turbidity, TSS and COD of the treatment of moringa seeds with rind and rindless were significantly different in each treatment. The real difference is seen in the presence of different alphabets in a single column. A significantly different value in the pH parameter was 70 mesh in all treatment using moringa seed powder with rind and rindless. The significant difference in turbidity parameter was 60 and 70 mesh with the treatment of the rind and rindless moringa seed. The value of TSS in the treatment of maize-skinned seeds was significantly different in the 60 and 70 mesh treatments. The COD value on the treatment of 70 mesh

using moringa seed with rind was significantly different with the same treatment but on the particle size of 60 and 80 mesh.

There is a significant difference between the parameters of the moringa seed powder with rind due to the presence of moringa seed skin which becomes impurities on the absorption mechanism during the coagulation process so that the kelor seed cannot work effectively. Based on sources from the reference [13], it can be seen that the value of protein on the skin of moringa seeds is quite low at around 15,680 ppm/gram. Similarly, protein in moringa seeds with rind that has a value of 73,547 ppm/gram lower than the rindless moringa seed of 147.280 ppm/gram. The lower protein values in the moringa seeds with rind because the proteins present in the moringa seed are covered by the amount of fiber that becomes the largest part of the kelor seed's skin. Moringa seed with rind that has a structure similar to peanut shells has a lot of fiber and little protein. The type of the fiber is insoluble, it triggers the rind of moringa seed to become an impurities substance that blocks the performance of coagulation flocculation [19]. Another possible theory is that the proteins present in the seeds of Moringa rind are denatured by warming during the conditioning process of moisture content. The protein will undergo bond alteration so that the ability of the cationic protein to absorb negative ions in coffee wastewater decreases or does not work at all.

The result of a treatment combination using rindless moringa seed at different particle sizes has different values because of the same alphabet in each column. This means that rindlessmoringa seeds do not have much different value results between the using of moringa seeds on 60, 70 or 80 mesh particle sizes. From the Duncan test results can be known that all treatment combinations have a value that is not significantly different. The best particle size is the size of 60 mesh particles in the rindless moringa seeds because the 60 mesh particles are easier when smoothed and sieved, when it is compared to the particle size of 70 and 80 mesh.

Table 3. Duncan Test Result

Treatments	pH	Turbidity	TSS	COD
K1P1	7.1 ± 0.0b	647.67 ± 16.77c	189.06 ± 4.13c	3626.67 ± 46.19c
K1P2	6.8 ± 0.0a	559.33± 261.82b	134.46± 64.41b	3040.00 ± 240.00b
K1P3	6.6 ± 0.577b	425.66 ± 36.31a	53.87± 8.93a	3493.33 ± 440.61c
K2P1	8.0 ± 0.0c	49.57 ± 3.30a	42.76 ± 0.81a	2189.67 ± 118.94a
K2P2	7.6 ± 0.557c	52.93 ± 3.81a	41.93 ± 0.94a	1887.33 ± 85.50a
K2P3	8.0 ± 0.0c	38.73 ± 6.03a	39.27 ± 1.48a	2243.33 ± 199.76a

Information: The same alphabet in a column indicated that it is not significantly difference in $\alpha \leq 0,05$ by using Duncan Test.

3.2.6. Efficiency of Treatments Combination

Coffee wastewater that has been processed by flocculation coagulation will do a measurement of the value of each parameter. Each treatment combination has a different value. The final value of each parameter will be compared with the initial characteristics of the coffee wastewater. This method is called as the efficiency of decreasing parameter of coffee wastewater which can be seen in Fig 8.

Value of turbidity efficiency and TSS was best in combination treatment of skinless rindless moringa coagulant with 80 mesh particle sizes with a turbidity efficiency value of $91.35 \pm 1\%$ and TSS efficiency $71.49 \pm 1\%$. The best value of COD efficiency was at treatment of rindless moringa coagulant with particle size of 70 mesh is $49.83 \pm 0.5\%$.

The efficiency obtained from the final measurement of parameters of each treatment which can be seen that the treatment of rindless moringa seed as coagulant has a great efficiency value on all parameters, except at the efficiency of COD is still below 50%. From the results of the efficiency, it can be concluded that the rindless moringa seeds was an effective treatment on turbidity decline, the TSS and COD. Leafy moringa seeds can also exclude the COD levels even if they are below 50%. The results of ANOVA calculations have also been explained that the treatment of rindless moringa seeds in various particle sizes is not significantly different from each other, meaning that the value of the parameters produced in the treatment of rindless moringa seeds on different sizes of particles tends to

be the same despite it has different efficiency values. Rindless moringa seed with 60 mesh particle sizes have a lower efficiency value when it is compared with the particle in size of 70 and 80 mesh. But one of the advantages possessed by the 60 mesh particle size is the easier powder making when compared with the particle size of 70 and 80 mesh especially if the tool used is mesh sieve and manual crusher.

The moringa seeds with rind have a very low efficiency values. The values on turbidity parameters, the TSS and COD are mostly also negative, meaning that the value of the parameters after treatment becomes greater than the initial value of the liquid waste parameter of coffee. Only 80 mesh particle size treatment results in a high value of turbidity efficiency and TSS. The efficiency of COD also has a low value on all treatments. The calculation of efficiency can be seen that the moringa seed is not that effective. Since, it cannot set aside the turbidity, TSS and COD up to 50%.

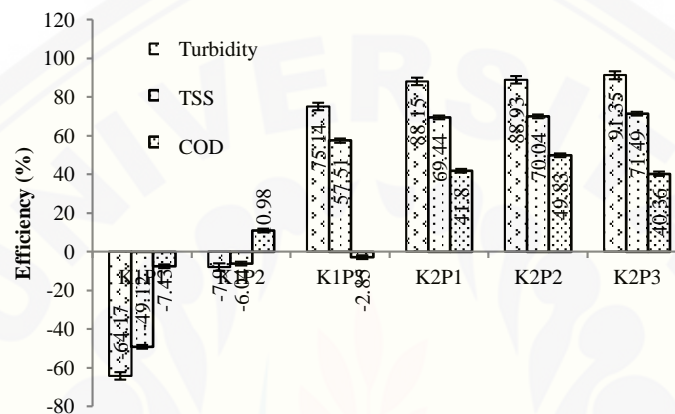


Figure 8. Efficiency of combination treatment

The things that affect the small value of the efficiency of all parameters in the treatment of moringa seeds rind is the presence of damage or the denaturation on the moringa seeds with rind when the heating process occurs. The protein will experience the early denaturation of structural changes that cause loss of protein function at a temperature more than 50°C, so that the protein contained in moringa seed rind is damaged and even lost [3]. The loss of these proteins, the only remaining content is insoluble fiber which cannot dissolve in water to make coagulant particles moringaseed with mixed skin. Moringa seed particles are able to absorb negative ions in the colloid, while moringa seed particles that are also used as coagulants cannot be the cause of a pulling force due to the destruction of proteins that make cations in the rind of moringa seeds do not react.

Similarly, the active substances name drhamnosyloxy - benzil- isothiocyanate contained in the core of moringa cannot work optimally and cannot absorb bacteria in coffee wastewater [20]. This is probably due to the coagulant particles which are still clot and can block the absorption of the active substances in the core of moringa seeds when coagulation process occurs because the rind particles and moringa seeds cannot be separated.

Conclusion

The best particle size treatment was in a 60 mesh using rindless moringa seed. This is partly due to the slight difference of the efficiency levels, values are not significantly different between the 60, 70 and 80 mesh particle sizes and it is easier to make the moringa seed dust on the particle size at mesh 60. The efficiency value of TSS, turbidity and COD degradation all use the 60 mesh was $69.44 \pm 1\%$; $88.15 \pm 0.5\%$ and $41.80 \pm 0.5\%$ respectively.

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