IOP Conference Series: Earth and Environmental Science

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Volume 1381

2024

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12th Engineering International Conference (EIC 2023) in conjunction with the 3rd International Conference on Engineering, Science, and Technology (ICEST 2023) 20/09/2023 - 20/09/2023 Online

Accepted papers received: 26 July 2024
Published online: 29 August 2024

Waste Treatment

IOP Conference Series: Earth and Environmental Science

Preface

To cite this article: 2024 *IOP Conf. Ser.: Earth Environ. Sci.* **1381** 011001

IOP Conf. Series: Earth and Environmental Science **1381** (2024) 011001 doi:10.1088/1755-1315/1381/1/011001

PREFACE

The 12th EIC, organized by the Faculty of Engineering at Universitas Negeri Semarang, Indonesia, took place successfully on September 20th, 2023. Themed "Innovation and Application of Green Technology for Post-Pandemic Recovery," this year's annual conference adopted a digital format through Zoom meetings and YouTube streaming, similar to the previous year, for enhanced accessibility and operational efficiency.

The conference commenced with the launch by the Academic Vice Rector of Universitas Negeri Semarang, who provided a brief institutional overview. The subsequent plenary session featured four keynote speakers from Thailand, Malaysia, Singapore, and Indonesia, each delivering a 45-minute speech followed by a 15-minute Q&A period. The entire session, conducted via Zoom, was expertly facilitated by moderators from the Faculty of Engineering at UNNES, attracting over 900 enthusiastic participants from the opening ceremony to the conclusion of the plenary session.

Post-plenary, 88 presenters from Indonesia, Malaysia, Thailand, and Taiwan were allocated to nine Zoom meeting rooms based on manuscript content for parallel session presentations. Each room had a moderator overseeing 10-minute presentations and 5-minute Q&A sessions, fostering excellent discussions and promoting idea sharing among presenters and participants.

Deep gratitude was expressed to the committee, partners, keynote speakers, presenters, participants, and all contributors for the success of the virtual conference despite the challenges posed by the pandemic. Attendees actively engaged throughout the session without notable issues. The best presenter from each parallel room was acknowledged at the conclusion, recognizing their exceptional efforts. Certificates were distributed to all keynote speakers, presenters, and conference attendees, serving as recognition of their valuable contributions.

This document compiles the accepted manuscripts of the 69 presenters, presenting research findings, concepts, data, and applications related to green technology theory, design, development, implementation, testing, and evaluation. Various engineering-related subjects are explored, showcasing the diverse areas where green technology is applied.

1) Biodegradable Materials
2) Biomass Conversion
3) Biotechnology and Bioprocess
4) Disaster Resilience Infrastructure
5) Energy Efficiency
6) Energy Management System
7) Environmental Monitoring
8) Green Chemicals
9) Green Construction
10) Green Materials
11) Green Technology System
12) Green Transportation
13) Intelligent Control System
14) Natural Disaster Mitigation
15) Renewable and Sustainable Materials

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16) Renewable Energy
17) Renewable Energy Power Generation
18) Renewable Resources
19) Sustainability in the Built Environment
20) Sustainable Architecture
21) Thermal Power Generation
22) Waste Treatment

The objective of this publication is to make a meaningful contribution to the progression of green technology. Additionally, we extend our wishes to all readers of these proceedings, hoping for both enjoyment and success in broadening their comprehension of engineering research. We appreciate the dedication and hard work of everyone involved and look forward to an even more successful conference in the coming year.

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Peer Review Statement

To cite this article: 2024 *IOP Conf. Ser.: Earth Environ. Sci.* **1381** 011002

IOP Conf. Series: Earth and Environmental Science **1381** (2024) 011002 doi:10.1088/1755-1315/1381/1/011002

Peer Review Statement

All papers published in this volume have been reviewed through processes administered by the Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing.

- **Type of peer review:** Single Anonymous
- **Conference submission management system:** Morressier
- **Number of submissions received:** 95
- **Number of submissions sent for review:** 94
- **Number of submissions accepted:** 70
- **Acceptance Rate (Submissions Accepted / Submissions Received × 100):** 73.7
- **Average number of reviews per paper:** 1
- **Total number of reviewers involved:** 5
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Lab scale investigation on biocoagulant performance to remove organic from tempe liquid waste treatment

IOP Conf. Series: Earth and Environmental Science **1381** (2024) 012038 doi:10.1088/1755-1315/1381/1/012038

Lab scale investigation on biocoagulant performance to remove organic from tempe liquid waste treatment

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Abstract. This study aims to determine the optimum coagulant dose and optimum mixing time from the use of trembesi seeds, tamarind seeds, and moringa seeds as biocoagulants in removing turbidity, TSS, BOD, and COD in a laboratory scale with variations in biocoagulant doses of 0, 10, 20, 30, 50, 70, 100, 500, 600, and 700 ppm, using coagulation speed of 200 rpm with variations of fast stirring time of 1, 2, and 3 minutes, and flocculation speed of 80 rpm with variations of slow stirring time of 15, 30, and 45 minutes. The results showed that the optimum biocoagulant dose of 500 ppm was able to remove max turbidity by 78%, 54%, and 69% for trembesi seed, tamarind seed, and moringa seed coagulants, respectively. The optimum fast mixing time is 2 minutes for trembesi seed and moringa seed coagulant, and 3 minutes for tamarind seed coagulant. Parameters BOD, COD, and TSS do not meet the quality standards of the Minister of Environment Regulation Number 5 of 2014. The speed of coagulation rotation in the reactor is 100 rpm for 1 minute and 20 rpm flocculation for 10 minutes. This study shows that the biocoagulants of trembesi seeds, tamarind seeds, and moringa seeds are effective as biocoagulants because they are able to remove >50% of the TSS parameter, but further research is needed regarding the potential of liquid waste effluent to become fertilizer.

1. Introduction

Tempe is a food made from soybean raw materials and the process still simple and limited to the household scale. Tempe is one of the comfort food and affordable price, processing soybeans into tempe can increase the economic value of soybeans, according to Shoffiantia [1]. Therefore, there has been a significant increase in tempe productions, especially in Semanan sub-District, West Jakarta.

However, according to Gunawan-Puteri [2] food industry in Indonesia such as tempe industrial activities, produce liquid waste that can pollute the environment around the tempe industrial. The higher production of tempe will increase the volume of wastewater produced, according to Adriawan [3]. In general, liquid waste discharged into the river is not equipped with Wastewater Treatment Plant (WWTP) [4]. According to Edahwati [5], characteristics in tempe industrial waste water is high organic matter content. These organic materials are BOD, COD, TSS, protein, carbohydrate, fat according to Sari [6]. The tempe industrial liquid waste is produced from the soybean washing process, the soaking, boiling, and cooking process during tempe productions

One of the additional ingredients added during water treatment is coagulant. According to Sandora [7], coagulants are chemical added to water precipitate colloid particles that are difficult to remove from water. The coagulants commonly used are chemical coagulant such as Poly Aluminium Chloride,

Chloride, Alum Sulfate, Ferrous Sulfate ($FeSO_4$), and Ferric Chloride ($FeCl_3$). Disadvantage of Alum is need to add additivies, Feric Chloride is corrosive and less economical, PAC has an expensive cost.

Chemical coagulant can trigger various neurological diseases such as Alzheimer's, besides that environmental damage. So, the solution can be used biocoagulants. Biocoagulant have several advantages compared to chemical coagulants, including being environmentally friendly. According to Pratama [8], biocoagulant is easly available raw materials, affordable prices, and biodegradable. Many plants in Indonesia can be used an alternative coagulant (biocoagulant), in this research used biocoagulants Trembesi seeds, Tamarind seeds, and Moringa seeds. According to Agustini [9], biocoagulant can be used for wastewater treatment is more economical and environmentally friendly. The impact of these biocoagulants on health is unknown and further research is needed.

The aim of this research is to determine the optimum coagulant dose and optimum mixing time from trembesi seeds, tamarind seeds, and moringa seeds as biocoagulants in removing BOD, COD, and TSS in a laboratory scale with variations in biocoagulant doses and variations of stirring time. From this research it's hoped that the biocoagulants of trembesi seeds, tamarind seeds, and moringa seeds are effective as biocoagulants in the wastewater treatment of the tempe industry, so the result of wastewater treatment can be safely disposed of into the environment without causing new problems.

2. Methodology

2.1. Tempe liquid waste sampling
The tempe liquid waste sample from tempe production house located in Komplek Pik Kopti No. No. 37, RT.11/RW.11, Semanan sub-District, Kalideres District, West Jakarta. The tempe liquid waste from boiling, soaking, and washing processes.

2.2. Research parameter analysis
Research parameter analysis methods are needed to determine the characteristics of tempe liquid waste and liquied effluent test results with a stirred batch reactor. The analyzed parameters are BOD, TSS, COD, pH, turbidity.

2.3. Preparation of moringa seed biocoagulant
Moringa seeds chosen are old seeds. Then Moringa seeds in the oven with a temperature of 105°C for 1 hour to reduce the water content. Moringa seeds were crushed using a blender into a powder and then sifted through an 80-mesh size.

2.4. Preparation of tamarind seed biocoagulant
Old tamarind seeds with brown color are roasted in oven 105°C to remove the water content, then peeled and ground until powder. The tamarind seed powder is sifted to 80 mesh size to make it easier to dissolve with solvent.

2.5. Preparation of trembesi seed biocoagulant
Trembesi seeds chosen are old seeds, which are generally yellow brown in color. The trembesi seeds were dried using an oven for 1 hour at 105°C. The Trembesi seeds are crushed using a blender to powder. The powdered Trembesi seeds were filtered through an 80-mesh size. In this research were used a biocoagulant in liquid. Preparation of Trembesi seed biocoagulant by dissolving seed powder with 1 M NaCl liquid. The mixed liquid was stirred using a magnetic stirrer for 15 minutes. After the stirring process, the liquid will be filtered. The filtrate from filtering process becomes a biocoagulant.

2.6. Determination of optimum dosage of biocoagulant
The beaker glass with 500 mL of tempe liquid waste sample, then 0 mg/L, 10 mg/L, 20 mg/L, 30 mg/L, 50 mg/L, 70 mg/L, 100 mg/L, 500 mg/L, 600 mg/L, and 700 mg/L are added Trembesi seed coagulant liquid to the beaker glass. The rapid stirring process was set 140 rpm for 2 minutes, which was calculated from the addition of various doses of the biocoagulant liquid and slow stirring process of 40 rpm for 45 minutes. Next step is sedimentation, the flocs formed are allowed to settle for 60 minutes

2.7 *Lab scale analysis*
Determine the optimum dose and optimum stirring time for laboratory-scale biocoagulant of trembesi seeds, tamarind seeds, and moringa seeds with jartest analysis. Volume of tempe liquid waste used during the jartest is 500 mL. The jar test was carried out twice, the first to determine optimum dose using a variation doses of 0, 10, 20, 30, 50, 70, 100, 500, 600 and 700 mg/L, coagulation speed of 200 rpm with variations fast stirring time of 1, 2, and 3 minutes by Trembesi seed and Tamarind seed biocoagulants and flocculation speed of 80 rpm with variations of slow stirring time of 15, 30, and 45 minutes. The variation of coagulation stirring time by Moringa seed biocoagulant was 2, 3, 4 minutes and flocculation 10, 12, 15 minutes.

3. Result and discussion
3.1 Initial characteristics
Tempe liquid waste produced from the tempe soaking process was used in this research. This determination is based on the BOD/COD ratio value which indicates the biodegradability of liquid waste. Ratio of BOD/COD data for tempe liquid waste can be seen in Table 1.

Table 1. Initial characteristics of tempe liquid waste

Tempe production process	Results		
	BOD (mg/l)	COD (mg/l)	BOD/COD
Boiling	2293	5440	0.42
Soaking	1245	6400	0.19
Washing	1845	640	2.88
Mixing	1613	7040	0.23

According to Tamyiz [10], if the BOD/COD ratio is <0.6 then it is non-biodegradable, and indicates that wastewater cannot be broken down through biological processes using the help of microorganisms. If the BOD/COD ratio ranges between 0.3 - 0.6 then it is slowly biodegradable, and shows that waste water can be broken down biologically, but the process will be slow because the decomposing microorganisms need time to adapt to the type of organic material in it. liquid waste samples. If the BOD/COD ratio is > 0.6 then it is biodegradable. This analysis shows that liquid waste can be broken down by microorganisms and can work effectively if processed through a biological process.

The liquid waste processing method used in this research uses a physical-chemical process by utilizing coagulation, flocculation and sedimentation processes which are based on the BOD/COD ratio of tempe liquid waste produced from the soaking process of 0.19 which shows that the liquid waste is non-biodegradable, so it is suitable to be processed using physical-chemical methods, such as research of Puspawati [11] using physical processes in processing tempe liquid waste because it is considered effective.

3.2 Optimum dosage of biocoagulant
Based on the variation of doses tested in this study, the results show that the optimum dose of biocoagulant for trembesi seeds, tamarind seeds and moringa seeds is 500 mg/L, as shown in Figure 1. This optimum dose is characterized by the highest reduction in turbidity and is turning point of biocoagulant dosage for processed tempe liquid waste. The respective turbidity allowances for tempe liquid waste processed using trembesi seed biocoagulant, tamarind seed, and moringa seed are 63%, 69%, and 63%.

There was a decrease in the percentage of turbidity removal from the optimum conditions at a biocoagulant dose concentration of 600 mg/L. This can happen because at this concentration there is no longer any binding of colloidal particles in tempe liquid waste that have different contents. The flocs that were previously formed will break apart again, so that the percentage of wastewater turbidity removal decreases, according to Haslinah [12].

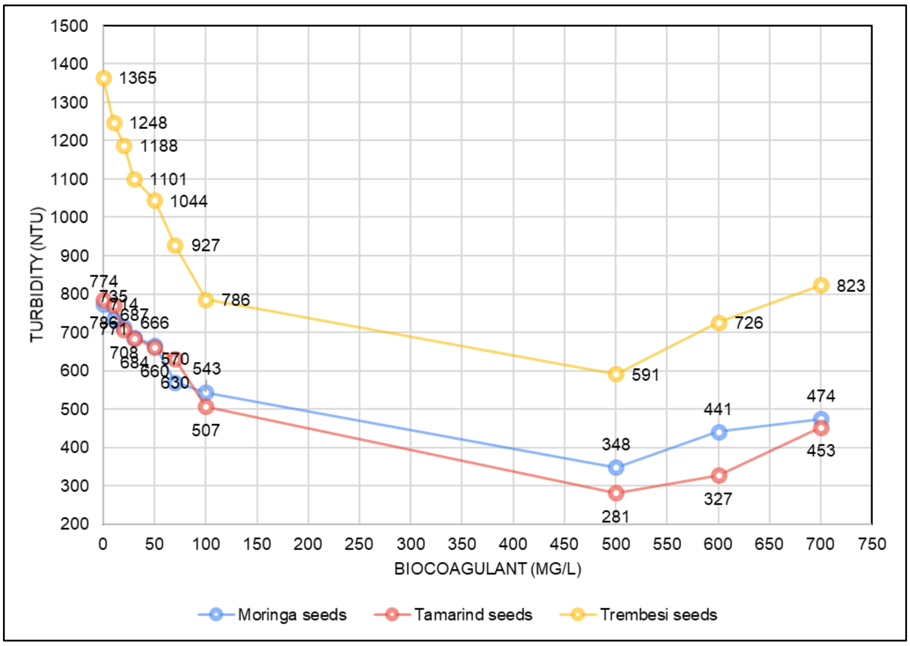


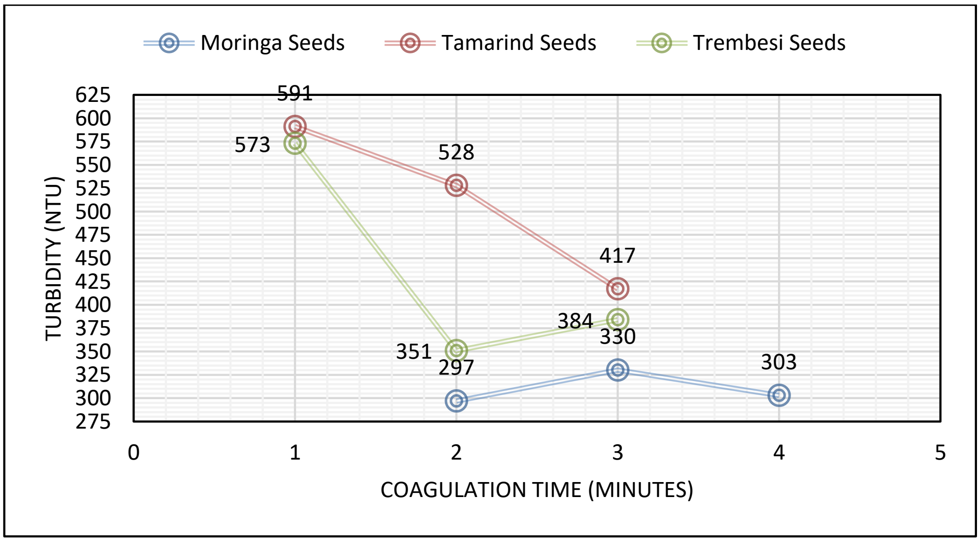
Figure 1. Optimum dose of biocoagulant

Based on the results of research of Asni [13] it is stated that the reduction in turbidity levels occurs because the fine suspended solids contained in wastewater can settle to form clumpy flocs, thereby reducing the turbidity level of wastewater. In this case, the level of turbidity and the TSS level are directly proportional, that is, if the TSS level in the wastewater is high then the level of turbidity in the wastewater is also high.

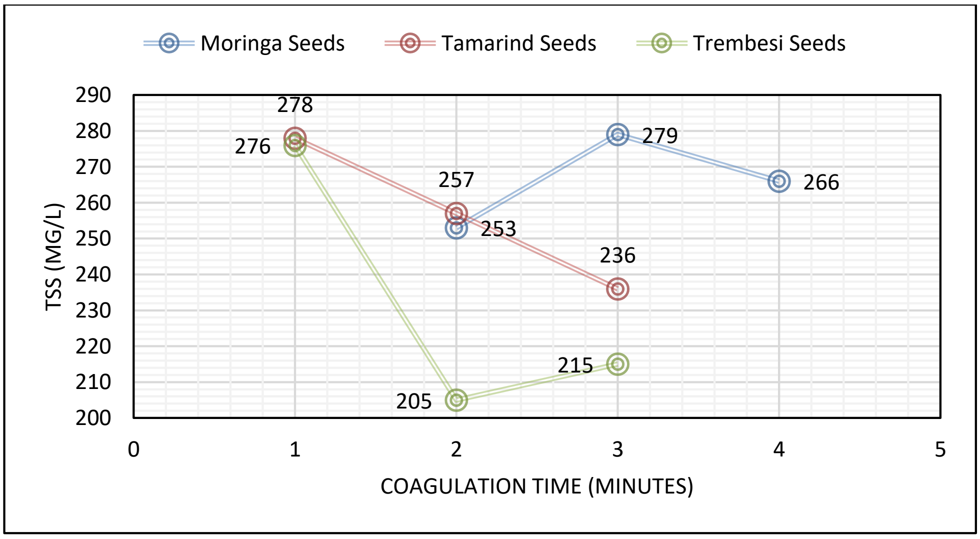
3.3 Lab scale experiment

Based on Figure 2 (a), it can be seen that the stirring time has an effect on turbidity as indicated by the optimum turbidity value for Moringa seed biocoagulant being a coagulation time of 2 minutes with a flocculation time of 10 minutes, namely with a final turbidity value of 297 mg/L with a removal efficiency percentage of 69 %. The turbidity value in liquid waste with tamarind seed biocoagulant decreased with increasing mixing time. The greatest reduction in turbidity by tamarind seed biocoagulant was at a coagulation stirring time of 3 minutes and a flocculation stirring time of 45 minutes with a removal efficiency percentage of 54%. The effect of stirring time on the optimum turbidity value in trembesi seed biocoagulant is a coagulation time of 2 minutes with a flocculation time of 30 minutes, namely the turbidity value decreases to 351 NTU with a percentage of turbidity removed of 78%. At a coagulation stirring time of 2 minutes and a flocculation stirring time of 30 minutes, the biocoagulant has had enough contact with the colloids so that the agglomeration process or formation of destabilized flocs occurs completely to form larger flocs. A larger floc size will make the settling process easier. When the mixing time for coagulation was 3 minutes and flocculation was 45 minutes, the mixing time was excessive, causing the floc size that had reached its maximum size to break down again into small particles that were difficult to settle. This results in the effectiveness of flocculation coagulation in removing turbidity decreasing.

The effect of stirring time on the TSS value can be seen in Figure 2 (b), the best removal of Moringa seed biocoagulant with a coagulation time of 2 minutes with a flocculation time of 10 minutes, namely with a final TSS value of 253 mg/L with a removal efficiency percentage of 58%. This is confirmed by research of Setyawati [14] which states that the optimum stirring time is 2 minutes which can reduce TSS from 587.5 mg/L to 100.4 mg/L at a dose of 2000 mg. Longer stirring times can provide more time for suspended solids to settle. Tempeh liquid waste contains colloidal particles that are difficult to settle, as in Aphirta [15] research, a longer stirring time can provide more opportunities for these colloidal particles to remain suspended.



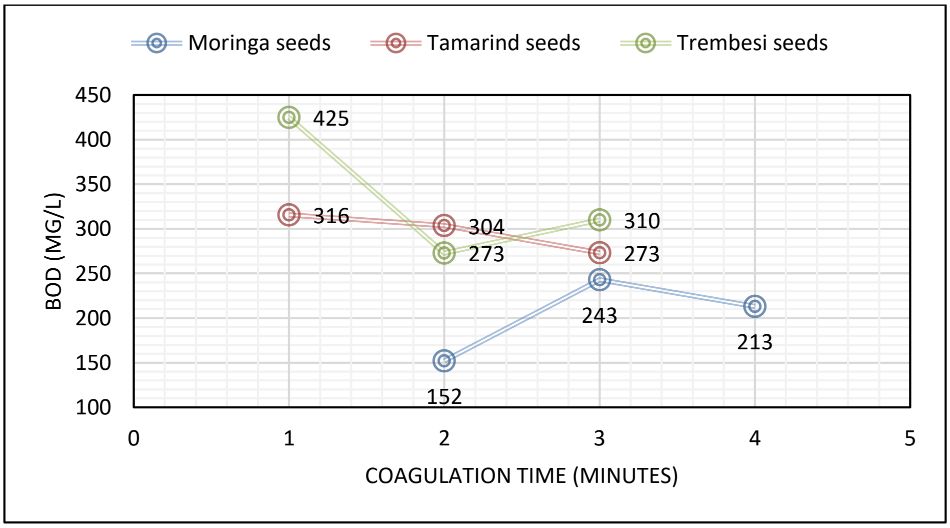
(a)



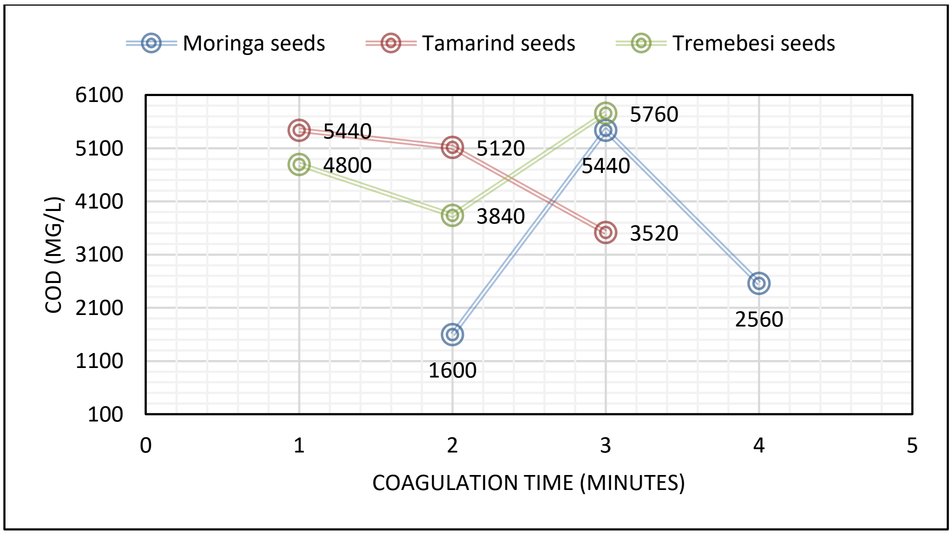
(b)

Figure 2. Relationship between stirring time and removal of (a) turbidity and (b) TSS

The TSS value in liquid waste with tamarind seed biocoagulant decreased with increasing mixing time. The largest decrease in TSS by tamarind seed biocoagulant was at a coagulation stirring time of 3 minutes and a flocculation stirring time of 45 minutes. Decrease in TSS value to 236 mg/L or 61%. A stirring time that is too short does not provide enough time for the particles to settle completely, so there is concern that there will still be particles dissolved in the liquid waste and the decrease in TSS will not be too significant. The effect of stirring time on the optimum TSS value in trembesi seed biocoagulant is a coagulation time of 2 minutes with a flocculation time of 30 minutes, namely the TSS value drops to 205 mg/L with a percentage of turbidity removed of 66%. After 3 minutes of coagulation stirring, the TSS value rose again because the flocs that had previously formed broke apart again. The coagulation stirring time does not meet the coagulation unit design criteria, a maximum of 1 minute.



(a)



(b)

Figure 3. Relationship between mixing time and removal of (a) BOD and (b) COD

Based on Figure 3 (a) and (b), it can be seen that the stirring time has an effect on the BOD and COD values. The effect of stirring time on the optimum BOD and COD values in Moringa seed biocoagulant is a coagulation time of 2 minutes with a flocculation time of 10 minutes, namely with a final BOD value of 152 mg/L with a removal efficiency percentage of 88% and a final COD value of 1600 mg/L with a percentage of removal efficiency 75%. This is confirmed by research of Setyawati [14] which states that the optimum stirring time is 2 minutes which can reduce BOD from 997 mg/L to 112 mg/L at a dose of 2000 mg. Moringa seed biocoagulant can contain active compounds which have the ability to accelerate the decomposition of organic materials through biochemical processes.

The optimum mixing time with tamarind seed biocoagulant is 3 minutes of coagulation and 45 minutes of flocculation. The reduction in BOD and COD with tamarind seed biocoagulant was 273.3 mg/L or 78%, and the reduction in COD was 3520 mg/L or 45%. According to Ramadhani [16], the optimum flocculation mixing time is 45 minutes with a BOD reduction of 82.62%. The tannin content in tamarind seed biocoagulant can bind and precipitate organic materials in tempeh liquid waste, resulting in a decrease in BOD concentration, according to Hardi [17].

The effect of stirring time on the optimum BOD and COD values in trembesi seed biocoagulant is a coagulation time of 2 minutes with a flocculation time of 30 minutes, namely the BOD value decreases to 273 mg/L with a percentage of BOD removed of 78%, and the COD value decreases to

3,840 mg /L with a percentage removed of 40%. The tannin content in trembesi seeds can work properly if the correct coagulant dose and optimum settling time are given. The process of deposition of organic matter through interaction with tannins in tempeh seeds can help reduce the concentration of organic matter in tempe liquid waste, which in turn can cause a decrease in BOD and COD concentrations.

4. Conclusion

The optimum dose of biocoagulant for moringa seeds, tamarind seeds and tamarind seeds is based on its effectiveness in reducing turbidity in tempe liquid waste, obtained at a dose of 500 mg/L. In Moringa seed biocoagulant the optimum mixing time is 2 minutes coagulation time with a flocculation time of 10 minutes, for tamarind seed biocoagulant the coagulation time is 3 minutes with 45 minutes flocculation, and for tamarind seed biocoagulant the coagulation time is 2 minutes with a flocculation time of 30 minutes. The highest turbidity and TSS removal efficiency was 78% and 66% by tempe seed biocoagulant, and the best biocoagulant in this study in removing BOD and COD from tempeh liquid waste was moringa seed biocoagulant with BOD and COD removal efficiency of 88% and 75% respectively.

Acknowledgments

Authors would like to send gratitude to Faculty of Landscape Architecture and Environmental Engineering Universitas Trisakti for funding this study according to contract for implementing superior faculty research Universitas Trisakti number 0490/PUF/FALTL-LPPM/IX/2023.

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