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The Effectiveness of the Combination of Moringa Seeds and Leaves (Moringa Oleifera) as a Natural Coagulant to Reduce Turbidity in Excavated Well Water in Wumialo Village, Gorontalo City

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ABSTRACT

Dug well water is still widely used by the community as a source of clean water, but the quality often does not meet turbidity requirements. High turbidity levels can reduce water quality and increase health risks, so effective, safe, and environmentally friendly water treatment efforts are needed by utilizing natural coagulants. The purpose of this study is to determine the effectiveness of the combination of moringa seeds and leaves (Moringa oleifera) as a natural coagulant in reducing the turbidity level of dug well water.

The type of experimental research with a pre-test-post test research design uses a combination dose of moringa seeds and leaves, namely 10 mg, 20 mg and 30 mg. The water sampling technique is Purposive sampling. Data analysis used the One-Way Anova test and the LSD (Least Significant Difference) follow-up test.

The results of the study showed that the turbidity value of dug well water in pre-test conditions was 15.5 NTU. The reduction in cloudiness after treatment with a dose of 10 mg had an average of 3.77 NTU (75.67%), the 20 mg dose of 2.53 NTU (83.67%), and the 30 mg dose of 3.17 NTU (79.54%). The Anova One-Way test showed a significant difference in effectiveness between doses of coagulants (p-value = 0.038 < 0.05). Follow-up LSD tests showed a significant difference between the 10 mg and 20 mg doses (p-value = 0.014 < 0.05), but there was no significant difference between the 10 mg and 30 mg doses (p-value = 0.146 > 0.05), as well as between the 20 mg and 30 mg doses (p-value = 0.128 > 0.05). It is recommended for subsequent researchers to test variations in stirring speed as well as other water quality parameters.

INTRODUCTION

Water is one of the resources that has an important role in the survival of all living things. As a major component in the human body (about 60-70% of the body's composition), water not only supports physiological functions such as metabolism, nutrient transport, and body temperature regulation, but also serves as the basis for a wide range of social, economic, and ecological activities. The availability of clean water is indispensable in various aspects of life. If the need for clean water is not met, the life of all living things on earth, especially for humans, can be threatened. Therefore, great attention is needed in its utilization and management. The provision of clean water to meet the needs of the community is one of the important schemes in ensuring the basic needs of the community (Saina et al., 2024).

In Indonesia itself, dug wells are still the main source of clean water supply for residents living in rural and urban areas. Dug wells are clean water facilities that take/utilize groundwater by digging holes in the ground by using their hands to get water Digging wells usually utilize shallow groundwater sources (Triana & Lilia, 2023). Dug wells as a source of clean water must be supported by structural requirements and location or land requirements for the manufacture of dug wells. This is necessary so that the water quality of the dug well is safe according to the rules that have been set (Badu et al., 2023).

Overall, the properties of water are grouped into physical, biological, and chemical categories. It aims to assess the quality of water so that it is suitable for consumption and use in a safe, hygienic manner, and supports human health. In water treatment that meets the requirements or quality standards, one of the physical purification parameters that must be considered is turbidity. The results of the examination of one of the water samples from the dug well in Wumialo Village for a turbidity level of 15.5 NTU are not eligible According to the Minister of Health Regulation No. 2 of 2023, clean water is <3 NTU (Nephelometric Turbidity Unit). The higher the level of turbidity, the higher the risk of human infection from diseases related to the digestive system.

One of the commonly used water treatment is the coagulation process. Coagulation is a water treatment process using coagulants that are used to remove colloidal particles and solutes in water. Coagulants can be classified into natural and synthetic (chemical) coagulants. The synthetic coagulants that are commonly used are aluminum sulfate and Poly Aluminum Chloride (PAC). Chemical Coagulants have several drawbacks, including high volume of sludge formation and high coagulant charges and can be toxic if used in high doses (Ambami et al., 2024).

One plant that shows great potential as a natural coagulant is Moringa oleifera, or better known as moringa. Moringa has long been known as a Miracle plant that has antimicrobial properties and the ability to purify water (Syamsuddin & Khaer, 2023). Moringa plants can act as a natural coagulant so that they are able to purify turbid water. In fact, moringa seed powder can be used as the fastest and simplest method to clean dirty water. Moringa seeds have various advantages, including the process of using coagulants which is very easy and economical, so it is considered a safer and more environmentally friendly alternative. The effectiveness of coagulation using moringa seeds is determined by the content of solid cationic proteins with a molecular weight of about 6.5 kdaltoz. The active substances contained in moringa seeds are Rhamnosyloxy-Benzyl-Isothiocyanate, this active substance is able to bind particles in water (Ambami et al., 2024). Moringa leaves can also be used to purify water because it contains nine amino acids, sucrose, D-glucose, alkaloids, wax, Quercetin and kaempferat also rich in potassium and calcium (R Jenny et al., 2022).

Research Objectives

The purpose of this study is to determine the effectiveness of the combination of seeds and moringa leaves (Moringa oleifera) as a natural coagulant in reducing the level of turbidity of dug well water in Wumialo Village, Gorontalo City.

RESEARCH METHODS

This research was conducted from December 2025 to January 2026 The sampling location was in Wumialo Village. The treatment location was at the Public Health Laboratory of Gorontalo State University and sample testing at the Analytical Chemistry Laboratory of Gorontalo State University. The type of research used is experiment with Research Design pre test-post test, pre test before treatment and post test after treatment with a combination of moringa seeds and leaves coagulant at doses of 10 mg, 20 mg and 30 mg.. Sampling techniques are Purposive sampling. Data analysis using ANOVA One-Way test and Advanced test LSD test (Least Significant Difference) to find out the difference between doses.

RESULTS

The turbidity rate of dug well water before and after being given a natural coagulant of a combination of seeds and moringa leaves

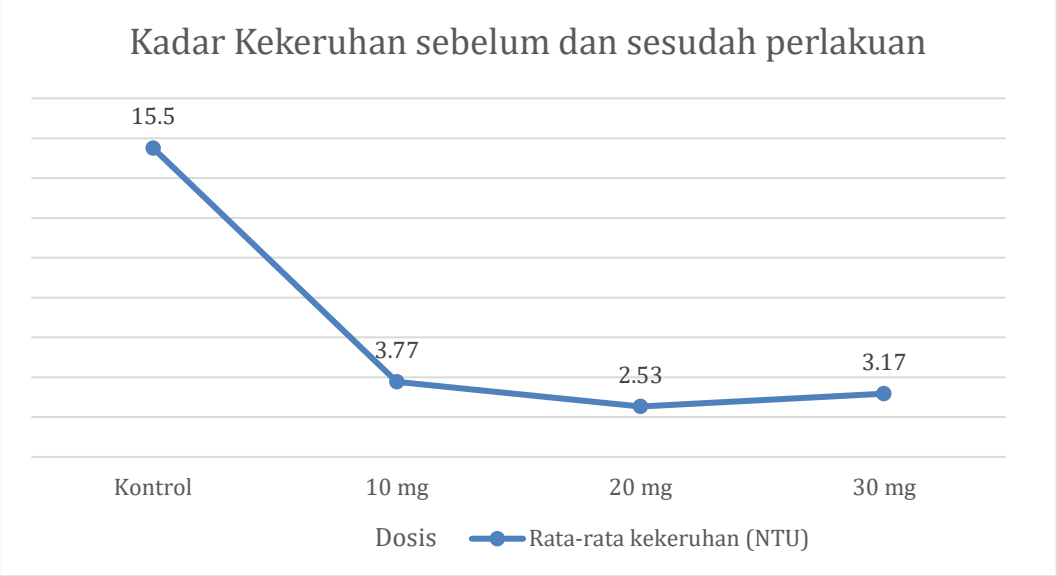
Table 1 Analysis Results of dug well water samples on turbidity parameters

Parameters	Dosage (mg)	Repetition			Average (NTU)	Present (%)	Quality Standard < 3 NTU
		I	II	III			
Turbidity	Controls	15,5	15,5	15,5	15,5	-	Not meeting standards
	10 mg	4,5	3,7	3,1	3,77	75,67	Not meeting standards
	20 mg	2,8	2,5	2,3	2,53	83,67	Meet standards
	30 mg	3,3	3,2	3,0	3,17	79,54	Not meeting standards

Source: Primary Data, 2025

Based on table 1 above, the pre-treatment value on the dug well water sample at the starting point (control) was 15.5 NTU, the results obtained did not meet the standards of the Minister of Health Regulation No. 2 of 2023 which sets the standard for clean water quality to be <3 NTU. The highest average value after treatment was carried out, the highest level of turbidity of dug well water occurred at a dose of 10 mg, which

was 3.77 NTU, this result did not meet the quality standard and the lowest average value of the turbidity level of dug well water occurred at a dose of 20 mg, which was 2.53 NTU, the results obtained met the clean water quality standard <3 NTU. The magnitude of the decrease in the turbidity level of dug well water can be seen in the graph below.



Source: Primary Data, 2025

Figure 1 Graph of Decrease in the Turbidity Rate of Excavated Well Water

Based on Figure 1, it shows changes in the turbidity value of dug well water before and after treatment using a combination of natural coagulants of moringa seeds and leaves with dose variations of 10 mg, 20 mg, and 30 mg. Based on the graph, it can be seen that the initial turbidity value (control) of 15.5 NTU experienced a significant decrease in all treatments. The 10 mg dose yielded an average turbidity value of 3.77 NTU, a 20 mg dose of 2.53 NTU, and a 30 mg dose of 3.17 NTU.

The lowest turbidity value was found at a dose of 20 mg, which indicates that this dose is the most optimal dose in reducing turbidity of dug well water compared to other doses. This indicates that at a dose of 20 mg, the coagulation process occurs more effectively resulting in a greater reduction in turbidity.

Analysis of the difference in effectiveness of the combination of seeds and moringa leaves in reducing the turbidity level of dug well water with doses of 10 mg, 20 mg and 30 mg

Data Normality Test

Table 2 Data Normality Test

		Shapiro-Wilk
	Coagulant Dosage (mg)	*p-value*
Turbidity	10	0.843
	20	0.780
	30	0.637

Source: Primary Data 2025

Based on table 2 above, it is known that the results of the data normality test using the Shapiro-Wilk test were obtained with a p-value of > 0.05 which means that the data is distributed normally.

Variance Homogeneity Test

Table 3 Variance Homogeneity Test

	p-value
Homogeneity of turbidity variance	0.176

Source: Primary Data, 2025

Based on table 3 above, it is known that the results of the variance homogeneity test using Levene's Test Of Equality Error Variance test obtained a p-value of 0.176 > 0.05 which means that the data has the same or homogeneous variance.

Anova One-Way Test

Table 4 Test One-Way Anova

Coagulant Dosage (mg)	*p-value*
10	0.038
20	
30	

Source: Primary Data, 2025

Based on table 4, it is known that the One-Way Anova test obtained a p-value = 0.038 < 0.05, so it can be said that there is a difference between the coagulant dose groups and water turbidity. This shows that the variation in the dose of coagulants has an influence on the effectiveness of reducing water turbidity. Because the results showed a difference in the reduction in turbidity at each dose, it was followed by an LSD (Least Significant Difference) test to determine the variation in the dosage of the combination of seeds and moringa leaves that were significantly different. The results can be seen in table 4.5 below.

Table 5 LSD test (Least Significant Difference)

(I) Coagulant Dosage (mg)	(J) Coagulant Dosage (mg)	*p-value*
10	20	0.014
	30	0.146
20	10	0.014
	30	0.128
30	10	0.146
	20	0.128

Source: Primary Data, 2025

Based on table 5 of the LSD (Least Significant Difference) test results, it is known that there is a significant difference between the dose of 10 mg and 20 mg to the reduction of turbidity (p-value = 0.014 < 0.05). So it can be concluded that the two doses have a noticeably different effect. The mean difference showed that a dose of 20 mg lowered turbidity more effectively than 10 mg. While there was no significant difference between the 10 mg and 30 mg doses (p-value = 0.146 > 0.05), and between the 20 mg and 30 mg doses (p-value = 0.128 > 0.05), the two doses were also not statistically significant.

DISCUSSION

The turbidity rate of dug well water before and after being given a natural coagulant of moringa leaf seeds

This study was carried out to measure the level of turbidity before treatment on the dug well water sample at the starting point (control), which is 15.5 NTU, The results obtained do not meet the requirements of the Minister of Health Regulation No. 2 of 2023 which stipulates that the standard for clean water quality is <3 NTU (Nephelometric Turbidity Unit). The level of turbidity after being treated using a combination of natural coagulants of seeds and moringa leaves using a dose of 10 mg in dug well water obtained a decrease of 3.77 NTU with an effectiveness of 75.67%, using a dose of 20 mg in dug well water obtained a decrease of 2.53 NTU with an effectiveness of 83.67%, and those using a dose of 30 mg in dug well water there was a decrease of 3.17 NTU with a percentage of 79.54%. Based on the clean water quality standard according to the Minister of Health Regulation No. 2 of 2023, the maximum limit of turbidity values for clean water is < 3 NTU. Based on the results of this study, only the 20 mg dose met the quality standard because it produced a final turbidity value of 2.53 NTU, while the doses of 10 mg and 30 mg were above the required standard values.

The turbidity value before treatment is very high due to the physical condition of the well which allows the entry of pollutants from the surrounding environment. Wells are in open areas without covers, so

soil sediment, dust, dry leaves, and organic matter can fall directly into the water. In addition, the existence of rice fields and surrounding vegetation causes surface water runoff to bring suspended particles into the well, especially when it rains. Other factors such as proximity to septic tanks and residential activities also have the potential to increase the burden of pollutants through groundwater seepage. This combination of conditions makes the physical quality of well water decrease and has an impact on the high turbidity value before the coagulation process is carried out. This is in line with the research of Nurjanah et al., (2021) who stated that turbidity in water is caused by the presence of suspended solids, both organic and inorganic substances. Inorganic substances are usually in the form of weathering rocks, sand, mud, and dissolved metals. Meanwhile, organic substances come from domestic waste disposal.

The reduction in turbidity after being given a combination of coagulant seeds and moringa leaves showed that the material effectively acted as a natural coagulant. Moringa seeds contain cationic proteins that are able to neutralize the negative charge of colloidal particles so that they form flocs that settle easily. This is in line with the research of Ananda et al., (2020) which states that protein in moringa seeds plays a role

as an effective natural coagulant. Meanwhile, moringa leaves contain flavonoid compounds and minerals that act as supporting coagulants in the particle binding process. Research by Alam et al., (2020) states that the use of a combination of moringa plant parts provides a more stable reduction in turbidity than a single use.

Based on the results of the study, a dose of 10 mg has the ability to reduce the turbidity of dug well water by 75.67%, according to Nurjanah et al., (2021), When a coagulant is added to the sample and followed by rapid stirring, the cationic proteins produced by Moringa oleifera are distributed throughout the liquid and then interact with the negatively charged particles that cause dispersed turbidity. These interactions affect the forces that cause the stability of the particles to be disturbed, so that they can bind to small particles to form a deposit. This process is called coagulation. Therefore Moringa oleifera can be referred to as a coagulant. Because this coagulant is derived from plants and without going through a synthetic process, it is also called a natural coagulant or biocoagulant. The final result of the 10 mg dose still does not meet the quality standard because the turbidity of the water produced is 3.77 NTU. At low doses such as 10 mg, the amount of coagulant (cationic protein) available is not enough to neutralize the entire negative charge of suspended particles in water. As a result, some particles remain stable and do not completely form large flocs that settle easily, resulting in a lower turbidity reduction effectiveness. Other studies have shown that at some low doses, Moringa's natural coagulant still does not reach the optimal amount to bind all suspended particles in raw water, so the turbidity reduction has not been maximized.

Based on the results of the study, the 20 mg dose is the most effective dose with a percentage reduction of 83.67% and produces a final turbidity value of 2.53 NTU, so that it meets the standard standards for clean water quality according to the Minister of Health Regulation No. 2 of 2023 (<3 NTU). According to Mali et al., (2022), water with a high level of turbidity requires the right dose of coagulants so that the process of deposition of colloidal particles that cause turbidity takes place optimally. This is in line with the research of Gustina et al., (2024) which states that the use of natural coagulants has an optimal dose point, where an excess dose can actually reduce the efficiency of the coagulation process.

Meanwhile, the 30 mg dose showed a reduced effectiveness of 79.54%, but the final turbidity value of 3.17 NTU did not meet the clean water quality standard, and the effectiveness was lower than the 20 mg dose. According to Mali et al., (2022) At higher concentrations, there is a decrease in the allowance because the coagulant concentration has exceeded the optimum concentration so that deflocculation occurs which causes the turbidity value to return.

According to Saina et al., (2024), in their research that the dose of coagulants has a great effect on reducing turbidity by providing the right dose, the reduction in turbidity in water will be more significant. If the coagulant is given too low, the amount of coagulant is not enough to bind the entire colloidal particles in the water. As a result, some of the particles remain suspended and the water still appears cloudy. If the coagulant is excessive, the system can undergo restabilization, which is a condition in which the particles return to stability and the floc is not formed, so that the turbidity value can increase again. Thus, this study shows that there is an optimal dose in the coagulation process using a combination of natural coagulants of seeds and moringa leaves, where the dose of 20 mg is the most effective dose in reducing the turbidity of the dug well water compared to the dose of 10 mg which is still less than optimal and the dose of 30 mg which shows a decrease in effectiveness due to excess coagulant. This condition suggests that the coagulation process does not necessarily increase with the addition of doses, but has a certain maximum point determined by the balance between the amount of coagulants and the concentration of suspended particles in the water.

Analysis of the difference in effectiveness of the combination of seeds and moringa leaves in reducing the turbidity level of dug well water with doses of 10 mg, 20 mg and 30 mg

Based on the results of the study, there was a difference in the combined dose of moringa seeds and leaves of 10 mg, 20 mg and 30 mg to the level of turbidity. Where the results of the examination show that the dose of 20 mg is proven to be the most effective in reducing the turbidity level of dug well water.

Based on the results of data analysis, it showed that there was a difference in effectiveness between the doses of 10 mg, 20 mg, and 30 mg (p-value = 0.038). A p-value of < 0.05 indicates that there is a difference in the effectiveness of reducing turbidity between the three doses. The results of the test explained that the dose variation had a noticeable effect on the effectiveness of reducing turbidity, but did not indicate which doses differed from each other. Therefore, follow-up analysis through Post Hoc tests to determine which groups provide meaningful differences.

The results of the Post Hoc LSD analysis showed that there was a significant difference between the dose of 10 mg and 20 mg, indicated by a significance value of 0.014 (p-value < 0.05). The results showed that the 20 mg dose resulted in a noticeably different reduction in turbidity compared to the 10 mg dose. Meanwhile, the comparison between the dose of 10 mg and 30 mg had a significance value of 0.146 (p-value > 0.05) and the comparison between the dose of 20 mg and 30 mg had a significance value of 0.128 (p-value > 0.05). These two values are greater than 0.05, so there is no significant difference between the two pairs.

At a low dose of 10 mg, the amount of coagulant given has not been able to neutralize all colloidal particles that cause turbidity, so the reduction in turbidity is not optimal. At the optimum dose of 20 mg, the positively charged protein from moringa seeds and leaves works more effectively in binding to negatively charged colloidal particles so that stable and easily settle flocs are formed. Meanwhile, at higher doses such as 30 mg, there is a condition where the particles can be restabilized due to excess coagulants, so that the decrease in turbidity does not increase significantly, and even tends to be lower than the optimal dose. According to research by Alam et al., (2020) and Gustina et al., (2024) it is also mentioned that the use of natural coagulants has an optimal dosing point, where excessive dose increases do not necessarily increase the effectiveness of turbidity reduction.

The results of this study confirm that the variation in coagulant dose plays an important role in determining the success of the process of reducing the turbidity of dug well water. Statistical analysis supports that the acquisition of a p-value of < 0.05 indicates a difference in effectiveness between the three dose groups. Further analysis through the LSD test reinforces the interpretation that the 20 mg dose is the most effective dose because it shows a significant difference to low doses, as well as meeting water quality standards. Therefore, the use of natural coagulants in combination with moringa seeds and leaves with the right dosage has the potential to be a simple technological alternative to improve people's water quality.

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that the turbidity value before treatment is 15.5 NTU, this value does not meet the standard standards for clean water quality according to the Minister of Health Regulation No. 2 of 2023 (< 3 NTU). The turbidity value after being given a combination of coagulant treatment of seeds and moringa leaves was only a dose of 20 mg which met the clean water quality standard resulting in a final turbidity value of 2.53 NTU.

The results of Anova's One-Way statistical test showed a significant difference in effectiveness between the three doses of coagulants (p-value = 0.038 < 0.05). This suggests that variation in coagulant dosage has an effect on reducing turbidity. The results of the Post Hoc LSD follow-up test showed that there was a significant difference between the 10 mg and 20 mg doses with a value of 0.014 (p-value < 0.05), while between the doses of 10 mg and 30 mg with a value of 0.146 (p-value > 0.05) and 20 mg and 30 mg with a value of 0.128 (p-value > 0.05) there was no significant difference between the two pairs of the group. These findings confirm that a dose of 20 mg is the optimal dose in the coagulation process using a natural coagulant combination of seeds and moringa leaves.

SUGGESTIONS

For the public, it is recommended to use moringa seed powder and leaves as natural coagulants to reduce the level of turbidity in the water of dug wells because the material is easy to obtain and environmentally friendly.

For the next researcher, it is recommended to add other parameters such as pH, TDS, TSS, as well as chemical and microbiological parameters in order to obtain a more comprehensive picture of water quality. In addition, the next researcher also needs to consider testing variations in stirring speed to see its effect on the floc formation process and the effectiveness of reducing turbidity.

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