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The Effect of Variations in Thickness and Mesh Size of Activated Carbon Media Based on Kepok Banana Peel and Coconut Shell on the Effectiveness of Iron (Fe) and Manganese (Mn) Reduction in Well Water

Pengaruh Variasi Ketebalan dan Ukuran Mesh Media Karbon Aktif Berbasis Kulit Pisang Kepok dan Tempurung Kelapa terhadap Efektivitas Penurunan Besi (Fe) dan Mangan (Mn) pada Air Sumur Bor

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ABSTRAK

Berdasarkan hasil laboratorium, nilai besi (Fe), mangan (Mn), dan pH pada sumur bor TPS 3R Terpadu Samarinda melebihi baku mutu yaitu secara berturut-turut 3,06 mg/L, 0,9 mg/L, dan 4. Oleh karena itu, penelitian ini bertujuan untuk mengetahui hubungan efektivitas penurunan besi dan mangan dengan variasi ketebalan dan ukuran mesh karbon aktif kulit pisang kepok dan tempurung kelapa dengan metode kuantitatif ekperimen semu dengan desain Non-Equevalent Control Group. Terjadi penurunan nilai Fe dan Mn serta perubahan pH untuk filtrasi dengan arang aktif tempurung kelapa pada ketebalan 30 cm dan 35 cm serta pada penggunakan arang aktif kulit pisang kepok dengan ketebalan 20 cm dan 30 cm. Penurunan nilai Fe dan Mn juga terjadi pada variasi ukuran mesh 4 dan ukuran mesh 8. Berdasarkan hasil tersebut, maka dapat disimpulkan bahwa terdapat hubungan ketebalan dan ukuran mesh terhadap penurunan kadar besi dan mangan dengan nilai Fisher Exact Test 0,029<0,05. Semakin tebal arang aktif maka persentase penurunan Fe dan Mn juga semakin besar karena semakin lama air berkontak dengan arang aktif.

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ABSTRACT

Based on laboratory results, the values of iron (Fe), manganese (Mn), and pH in the borehole well TPS 3R Terpadu Samarinda exceed quality standards of 3.06 mg/L, 0.9 mg/L, and 4, respectively. Therefore, this study aims to determine the relationship between the effectiveness of iron and manganese reduction and variations in the thickness and mesh size of activated carbon derived from kepok banana peel and coconut shell, using a quasi-experimental quantitative method with a Non-Equivalent Control Group design. There was a decrease in Fe and Mn values and changes in pH for filtration with coconut shell activated carbon at a thickness of 30 cm and 35 cm, and when using activated carbon from kepok banana peel with a thickness of 20 cm and 30 cm. The decrease in Fe and Mn values also occurred in variations in mesh size 4 and mesh size 8. Based on these results, it can be concluded that there is a relationship between thickness and mesh size and the decrease in iron and manganese levels, with a Fisher's Exact Test value of $0.029 < 0.05$. The thicker the activated carbon, the greater the percentage of Fe and Mn reduction, because the longer the water remains in contact with it.

1. INTRODUCTION

1.1 Background

The daily water requirements highlight the importance of water for human life and the environment. The higher a person's standard of living, the more water they need (Arifin et al., 2022). However, not all water is suitable for consumption because it is susceptible to contamination by microorganisms and chemicals such as iron (Fe), manganese (Mn), lead (Pb), and mercury (Hg), which are dangerous if they exceed quality standards (Ndibale et al., 2022). The East Kalimantan Provincial Statistics Agency reported that in 2022, raw water uses mostly came from rivers at 74.35%, but some communities may still use water from other sources, such as groundwater at 9.46% (Central Statistics Agency, 2023). Water problems are often found in groundwater because it is directly used by humans and is prone to contamination from waste produced by various human activities. Groundwater often comes into contact with various materials that degrade its quality, so that it no longer meets drinking water and clean water standards (Ariyani, 2019). Borehole water at certain depths has high iron (Fe) content, exceeding quality standards and failing to meet health requirements (Ulfah & Sugiri, 2023). The deeper the borehole, the higher the iron (Fe) content (Jusriana et al., 2023).

Previous research on the use of coconut shell activated carbon to meet groundwater quality standards for pH, Mn, and Fe in Muara Badak, Kutai Kartanegara, East Kalimantan Province. It is known that the dosage of coconut shell activated carbon affects the pH, iron (Fe), and manganese (Mn) levels in the adsorption process. The addition of 4 grams of activated carbon increased the pH by >65%, reduced Fe by >90%, and reduced Mn by >91%. This shows that the more coconut shell activated carbon media used, the higher the pH will be and the lower the amount of iron and manganese in the water (Devy et al., 2024). Treatment of dug well water with a combination of chlorination and zeolite sand filtration can reduce Fe by 98% and Mn by 90% (Sembiring & Tanjung, 2022). Sand-and-gravel media arranged in three parallel filters can reduce iron, manganese, and turbidity (Saputra et al., 2024). The Biological Aerated Filter (BAF) method is also effective in reducing Fe and Mn content in clean water treatment (Marsidi et al., 2018).

According to research conducted by Hafiz (2023) on how the use of kepok banana peel residue as an adsorbent in the filtration process of Fe and Cd levels contained in well water in the village of Lamkeunung, Aceh Besar, the researcher applied different masses, namely 5 g, 6 g, 7 g, and 8 g, and stirred for 10–30 minutes at a speed of 200 rpm. The results showed that kepok banana peel was effective in reducing Fe levels with a mass application of 5 g and a stirring time of 10 minutes, achieving an efficiency of 92.59% and the highest absorption achievable with this method of 100.1 mg/L. Activated charcoal is made by mixing kepok banana peel, and coconut shell charcoal with potassium hydroxide (KOH), which acts as an activator, increasing porosity and metal adsorption and improving activated charcoal's ability to adsorb organic and inorganic substances from solutions. In this regard, the addition of potassium hydroxide (KOH) as an activator in the activated charcoal production process plays an important role in improving the quality and efficiency of the activated charcoal produced, making it more effective in its use (Nurfitria et al., 2019). Filtration using zeolite and activated carbon media reduces the Fe and Mn content (Amna & Wahyuningsih, 2019).

The Mugirejo 3R Waste Management Facility is a waste processing site based on the reduce, reuse, and recycle concept, located in Mugirejo Village, Sungai Pinang District, Samarinda City, East Kalimantan Province. The Mugirejo 3R Waste Management Facility was chosen as the research site because, according to a survey, it uses well water for its operations. Water samples were collected at the Regional Health Laboratory of Samarinda City because the well water appeared turbid and had an iron-like odor. Laboratory analysis results showed that the iron (Fe) and manganese (Mn) levels in the well water exceeded the threshold recommended by Indonesian Minister of Health Regulation No. 2 of 2023 concerning water, sanitation, and hygiene requirements (Indonesian Ministry of Health, 2023). The quality of the borehole water at the Mugirejo 3R TPS had a measurable manganese (Mn) content of 0.9 mg/L, iron (Fe) content of 3.06 mg/L, and a pH of 4.

Based on the above issues, the question arises as to whether there is a relationship between the effectiveness of reducing iron (Fe) and manganese (Mn) levels in well water and variations in the thickness and mesh size of activated carbon filter media made from kepok banana peel and coconut shells. The novelty of this study lies in the combination of kepok banana peel and coconut shell as raw materials for the production of activated carbon, using potassium hydroxide (KOH) as an activator to increase the adsorption capacity of the activated carbon for iron (Fe) and manganese (Mn) in the treatment of borehole water. This is different from previous studies, which mostly used coconut shells or traditional filtration media such as sand and zeolite. This study explores variations in filter media thickness and activated carbon mesh size to determine the optimal efficiency in reducing Fe and Mn levels. Additionally, this research contributes scientifically to the development of more efficient, sustainable, and locally sourced filtration technology, serving as an alternative solution to improve groundwater quality

1.2 Research Objective

The purpose of this study was to determine the reduction of iron and manganese using activated charcoal from coconut shells and plantain peels with different thicknesses and mesh sizes. In addition, this study aimed to analyze the relationship between reductions in iron and manganese and variations in the thickness and mesh size of activated carbon filter media made from plantain peels and coconut shells.

2. METHOD

The method used was a quasi-experimental quantitative method with a non-equivalent control group design aimed at comparing the results of the research experiment using treatment and control without treatment. In this design, the experimental sample and control were not randomized. The non-equivalent control group design can be seen as follows:

Table 1. Non-equivalent control group design pre-test post-test

	Pre-test	Treatment	Post-test
Experiment	01	X	02
Control	01		02

The research design used was *a* Control Group Pretest Posttest, in which the initial water sample (pre-test) was tested first before treatment was carried out, then the water sample was treated (post-test) with two variations in the thickness of activated charcoal from kepok banana peel in two filters, each with an activated charcoal thickness of 20 cm and 30 cm. Similarly, coconut shell activated charcoal is tested at thicknesses of 30 cm and 35 cm in two filters, as well as in one control filter containing banana peel and coconut shell charcoal without 20% KOH activation. After sampling the water, it was tested at the Samarinda City Health Laboratory. The research methodology flowchart is shown in Figure 1.

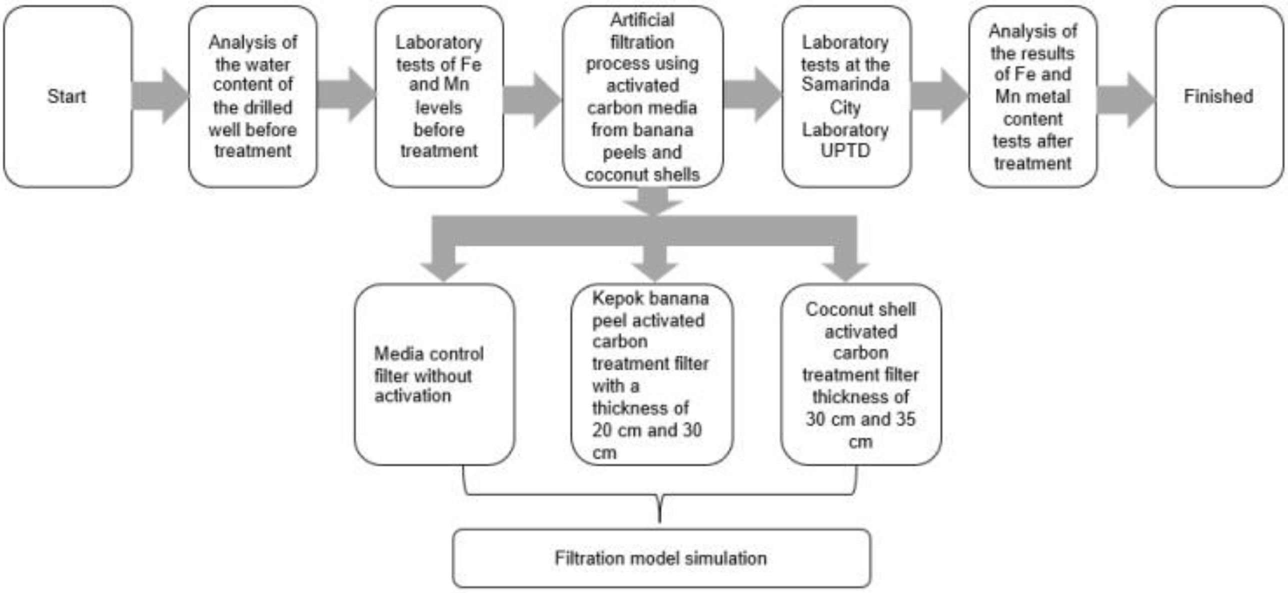

Figure 1. Research methodology flowchart

The research began with a preliminary test to analyze the borehole's water content before treatment. Water samples were taken from the borehole tap at the research site using containers, and then the iron and manganese levels were determined using a water test kit. After that, 1 liter of water samples was further analyzed at the Samarinda Regional Health Laboratory UPTD, with results that did not meet the quality standards set by Regulation of Minister of Health of The Republic of Indonesia Number 2 of 2023 regarding sanitation and hygiene. After the preliminary test was conducted, activated carbon, and water filters were made, then the filtration process was carried out using activated carbon from kepok banana peels and coconut shells. After that, laboratory tests and analyses of the iron and manganese metal content after treatment were conducted.

2.1 Research Time and Location

The research was conducted from April 2024 to July 2024. Sampling was carried out at the research site located at the Mugirejo Integrated 3R Waste Management Facility in Samarinda City, East Kalimantan, and then tested in the laboratory at the East Kalimantan Provincial Health Laboratory Technical Implementation Unit.

2.2 Tools and Materials

The equipment used in this study included 4-inch PVC pipes designed as water filters, 4-mesh and 8-mesh sieves, pH paper, and sample bottles. The carbonization process used several tools, including an oven and used cans. Meanwhile, the materials used in this study included activated charcoal from banana peels and coconut shells, gravel, silica sand, and bio foam. Activated charcoal production requires KOH and distilled water. The filtration device schematic is shown in Figure 2.

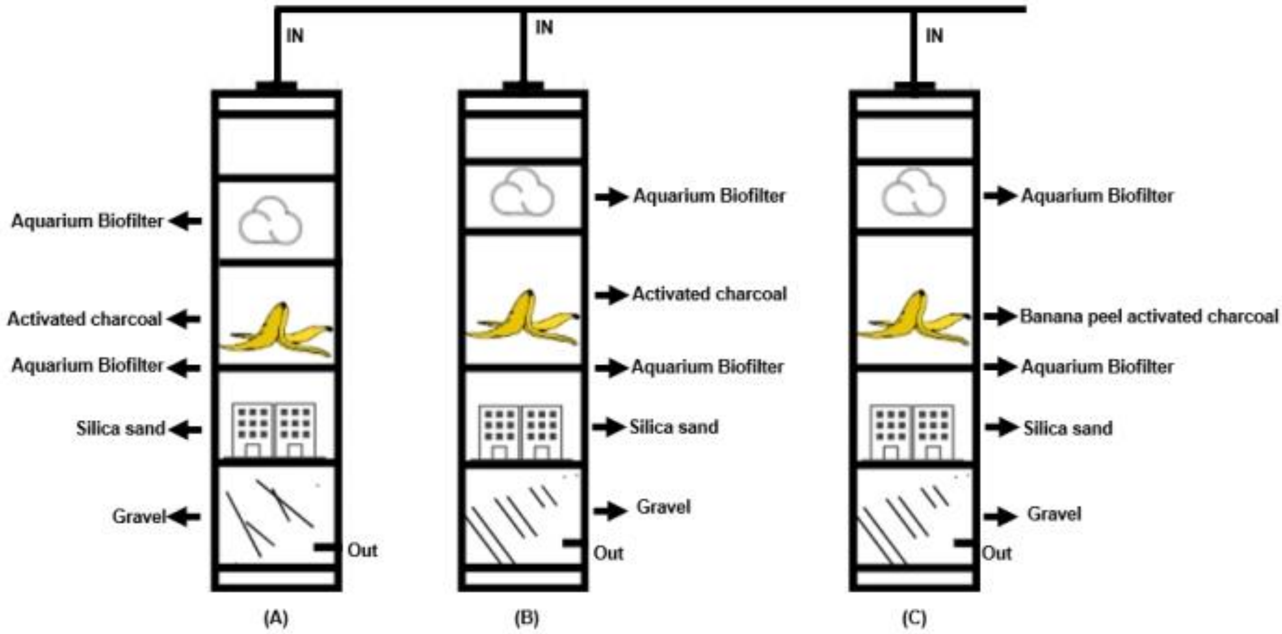

Figure 2. Filtration equipment diagram

2.3 Research Procedure

The method used in this study was a quasi-quantitative method aimed at assessing the effectiveness of a treatment. In this study, neither the samples nor the controls were randomly selected. The study began with the sorting and cleaning of kepok banana peels and coconut shells, followed by several stages, including the carbonization process. First, the kepok banana peels and coconut shells were cleaned thoroughly with clean water, then drained and placed in an oven at 110 °C for 24 hours, while the coconut shells were dried in the sun. After being in the oven, the banana peels were left to cool, then the kepok banana peels and coconut shells were burned using used cans with incomplete combustion. After the kepok banana peels and coconut shells were charred, they were ground and sieved using 4 Mesh and 8 Mesh sieves. After the charcoal is sifted, it enters the charcoal activation process, during which it is soaked in a 20% KOH solution for 24 hours while being stirred occasionally. After soaking, the charcoal is filtered, rinsed with distilled water, and dried in the sun. The dependent variables in this study were activated carbon from kepok banana peels and coconut shells, sized 4 mesh and 8 mesh, with thicknesses of 20 cm, 30 cm, 30 cm, and 35 cm in each reactor. The independent variable was the contact time of the water flow in each reactor.

2.4 Analysis

The next step is the analysis process of activated charcoal from banana peels and coconut shells that will come into contact with well water. The filter works by flowing well water through a filter designed with varying thicknesses and mesh sizes. After the filtered water results are tested in the laboratory, analyze the effectiveness using the Chi-Square test and calculate the effectiveness of activated charcoal using the following equation 1:

$$Efficiency\ (\%) = \frac{(C1-C2)}{C1}\ X\ 100\% \quad \text{...} \quad (1)$$

Explanation:
C1 = Heavy metal concentration before filtration (mg/L)
C2 = Heavy metal concentration after filtration (mg/L)

Figure 3. Documentation of research activities

3. RESULTS AND DISCUSSION

3.1 Results of Fe and Mn Content Testing Before Filtration

The water samples tested were sourced from bore wells at waste management sites used by TPS managers for hygiene and sanitation. The tests were conducted at the East Kalimantan Provincial Laboratory Technical Implementation Unit (UPTD). The laboratory results are shown in Table 2, indicating that the iron (Fe), manganese (Mn), and pH levels of the TPS 3R borehole water do not meet or exceed the quality standards set in the Indonesian Minister of Health Regulation No. 2 of 2023 concerning hygiene and sanitation requirements. The permissible quality standards for iron (Fe) are 0.2 mg/L, manganese (Mn) 0.1 mg/L, and pH 6.5–8.5. Table 2 shows the initial test results for iron content at 3.06 mg/L, manganese content at 0.9 mg/L, and pH at 4, indicating the need for water treatment at the TPS 3R Integrated Mugirejo Samarinda borehole.

Table 2. Iron (Fe) and manganese (Mn) levels before filtration

Parameter	Result		
	Laboratory Results	Quality Standards	Description
Iron (Fe)	3.06 mg/L	0.2 mg/L	Does not meet requirements
Manganese (Mn)	0.9 mg/L	0.1 mg/L	Does not meet requirements
pH	4	6.5–8.5	Does not meet requirements

Source: test results from the Samarinda City Laboratory UPTD

3.2 Effectiveness of Iron and Manganese Reduction with Variations in Activated Carbon Mesh Size

Laboratory test results are shown in Table 3. Coconut shell and banana peel activated carbon with mesh sizes of 4 and 8 reduced iron and manganese levels, with the control serving as a comparison.

Table 3. Effectiveness of iron and manganese reduction with variations in activated carbon mesh size

Sample Type	Parameter	Before Treatment	After Treatment	Effectiveness	Quality Standard
Well Water A (Coconut shell charcoal control)	Iron	3.06 mg/L	2.89 mg/L	5.56%	0.2 mg/L
	Manganese	0.9 mg/L	1.4 mg/L	55.56%	0.1 mg/L
	pH	4	6	-	6.5–8.5
Well Water H (Banana peel charcoal control)	Iron	3.06 mg/L	3.04 mg/L	6.53%	0.2 mg/L
	Manganese	0.9 mg/L	1.1 mg/L	22.22%	0.1 mg/L
	pH	4	6	-	6.5–8.5
Well Water B (Mesh 4 activated charcoal from coconut shells)	Iron	3.06 mg/L	2.31 mg/L	24.52%	0.2 mg/L
	Manganese	0.9 mg/L	0.7 mg/L	22.22%	0.1 mg/L
	pH	4	7	-	6.5–8.5
Well Water C (Mesh 8 activated charcoal from coconut shells)	Iron	3.06 mg/L	2.20 mg/L	28.10%	0.2 mg/L
	Manganese	0.9 mg/L	0.6 mg/L	33.33%	0.1 mg/L
	pH	4	7	-	6.5–8.5
Well Water J (Mesh 4 activated charcoal banana peel)	Iron	3.06 mg/L	2.09 mg/L	5.22%	0.2 mg/L
	Manganese	0.9 mg/L	0.5 mg/L	44.44%	0.1 mg/L
	pH	4	4	-	6.5–8.5
Well Water I (Mesh 8 activated charcoal from kepok banana peel)	Iron	3.06 mg/L	1.37 mg/L	55.22%	0.2 mg/L
	Manganese	0.9 mg/L	0.2 mg/L	77.77%	0.1 mg/L
	pH	4	9	-	6.5⁻ 8.5

Source: test results from the Samarinda City Laboratory UPTD

Based on Table 3, the iron and manganese levels before treatment with coconut shell-activated carbon and banana peel-activated charcoal were 3.06 mg/L for iron and 0.9 mg/L for manganese, with a pH of 4. These levels do not meet clean water quality standards, as the iron in manganese content exceed 0.2 mg/L and 0.1 mg/L, respectively. In well A, in the coconut shell charcoal control filter test, the iron content decreased to 2.89 mg/L (5.56%), manganese increased to 1.4 mg/L (55.56%), and the pH increased to 6. In the borehole H water in the banana peel charcoal control filter test, the iron (Fe) content decreased to 3.04 mg/L, representing 6.53%, while the manganese (Mn) content increased to 1.1 mg/L, representing 22.22%, and the pH increased to 6. Tests on coconut shell charcoal and banana peel charcoal control filters can result in decreases in iron, manganese, and pH levels.

The decrease in iron content was only 5.56%, while manganese content increased by 55.56%. The increase in manganese content could be due to desorption or to the activated carbon's inability to adsorb manganese efficiently in this test. This is in line with research by Fadhillah & Wahyuni (2016), which reported that activated carbon's accumulation efficiency can vary under specific conditions, such as pH, contact time, and initial contaminant concentration.

In the filter test using a mesh size of 4, activated charcoal from coconut shells reduced the iron content to 2.31 mg/L (24.51%), the manganese content to 0.7 mg/L (22.22%), and the pH to 7. For mesh size 4 in the banana peel activated carbon filter test, the iron content decreased to 2.90 mg/L (5.22%), manganese decreased to 0.5 mg/L (44.44%), and the pH remained at 4. In the mesh size 8 coconut shell activated carbon filter test, the iron content decreased to 2.20 mg/L, representing 28.10%, manganese decreased to 0.6 mg/L, representing 33.33%, and the pH increased to 7. For mesh size 4 in the banana peel activated charcoal filter test, the iron content decreased to 1.37 mg/L, corresponding to 55.22%, and the manganese content decreased to 0.2 mg/L, corresponding to 77.77%, while the pH remained at 4. Despite reductions in iron and manganese levels with both coconut shell-activated carbon and banana peel-activated carbon, the levels still did not meet the quality standards set in Regulation of Minister of Health of The Republic of Indonesia Number 2 of 2023.

The results of the study showed that 4-mesh activated banana peel charcoal reduced iron levels to 2.09 mg/L, a decrease of 5.22%, and manganese levels to 0.5 mg/L, a decrease of 44.44%. This shows that activated banana peel charcoal is more effective in reducing iron and manganese levels. However, the reduction in iron and manganese levels has not yet reached the established quality standards. Meanwhile, with a mesh size variation of 8, the iron level decreased to 1.37 mg/L, a 55.22% decrease, and the manganese level decreased to 0.2 mg/L, a 77.77% decrease. In the study by Asmar et al. (2021), activated carbon has a large number of pores of a certain size, which function to absorb fine particles and trap them in the pores. This causes activated charcoal to absorb iron and manganese, binding them within in pores.

3.3 Effectiveness of Iron and Manganese Reduction Using Activated Charcoal Media

In this study, water filter testing was conducted using coconut shell activated charcoal with thicknesses of 30 cm and 35 cm, and kepok banana peel with thicknesses of 20 cm and 30 cm. The test results are shown in Table 4 below:

Table 4. Effectiveness of iron and manganese reduction with activated carbon thickness

Sample Type	Parameter	Before Treatment	After Treatment	Effectiveness	Quality Standard
Well Water A (Coconut shell charcoal control)	Iron	3.06 mg/L	2.89 mg/L	5.56%	0.2 mg/L
	Manganese	0.9 mg/L	1.4 mg/L	55.56%	0.1 mg/L
	pH	4	6	-	6.5–8.5
Well Water H (Banana peel charcoal control)	Iron	3.06 mg/L	3.04 mg/L	6.53%	0.2 mg/L
	Manganese	0.9 mg/L	1.1 mg/L	22.22%	0.1 mg/L
	pH	4	6	-	6.5–8.5
Well Water E (Thickness 30 activated charcoal coconut shells)	Iron	3.06 mg/L	2.69 mg/L	12.09%	0.2 mg/L
	Manganese	0.9 mg/L	0.7 mg/L	22.22%	0.1 mg/L
	pH	4	7	-	6.5–8.5
Well Water D (Thickness 35 activated charcoal coconut shells)	Iron	3.06 mg/L	2.51 mg/L	17.97%	0.2 mg/L
	Manganese	0.9 mg/L	0.1 mg/L	88.89%	0.1 mg/L
	pH	4	7	-	6.5–8.5
Well Water G (Thickness 20 activated charcoal banana peel)	Iron	3.06 mg/L	2.81 mg/L	8.17%	0.2 mg/L
	Manganese	0.9 mg/L	0.4 mg/L	55.56%	0.1 mg/L
	pH	4	7	-	6.5–8.5
Well Water F (Thickness 30 activated charcoal banana peel)	Iron	3.06 mg/L	1.10 mg/L	64.05%	0.2 mg/L
	Manganese	0.9 mg/L	0.3 mg/L	66.67%	0.1 mg/L
	pH	4	7	-	6.5–8.5

Source: test results of the Samarinda City Laboratory UPTD test

The results show that there were changes in iron and manganese before and after the filtration process in both the control group and the treatment group, with variations in thickness of 30 cm and 35 cm of coconut shell activated charcoal and thicknesses of 20 cm and 30 cm of banana peel activated charcoal. from the initial test results of Fe 3.06 mg/L and Mn 0.9 mg/L to 2.69 mg/L in the coconut shell control, with an efficiency of 5.56% and Mn increased to 1.4 mg/L with an efficiency of 55.56%. With 30 cm and 35 cm of coconut shell activated charcoal, the levels were 2.69 mg/L and 2.51 mg/L, with reduction efficiencies of 12.09% and 17.97%, respectively. The Mn levels were 0.7 mg/L and 0.1 mg/L with an efficiency of 22.22% and 88.89%. In the banana peel control, Fe decreased by 3.04 mg/L with an efficiency of 0.65%, and Mn increased by 1.1 with an efficiency of 22.22%. At 20 cm and 30 cm thick, banana peel-activated charcoal reduced iron levels to 2.81 mg/L and 1.10 mg/L, with efficiencies of 8.17% and 64.05%, respectively. The Mn levels were 0.4 mg/L and 0.3 mg/L, with reduction efficiencies of 55.56% and 66.67%, respectively. Based on the above test results, activated charcoal reduced the levels of heavy metals, iron and manganese in well water, but none of the parameters met the quality standards of Regulation of Minister of Health of The Republic of Indonesia Number 2 of 2023 for hygiene and sanitation purposes.

The results of laboratory tests on experiments after filtration with 35 cm-thick coconut-shell activated charcoal show that it is more effective in reducing iron and manganese levels, thereby meeting the quality standards set by Regulation of Minister of Health of The Republic of Indonesia Number 2 of 2023. Increasing the thickness of activated charcoal significantly improves the effectiveness of reducing heavy metal levels and increasing water pH. Research conducted by Sangadjisowohy & Muhammad (2019) showed that a 30 cm-thick layer of coconut shell can be used to produce activated charcoal media, with a processing effectiveness of 60% and an average salinity reduction of 0.2%.

Previous research conducted by Deni Asmar et al. (Asmar et al., 2021) entitled "The ability of several variations of local banana peel to reduce iron (Fe) in water" successfully reduced the iron content of well water in the range of 69.90%–76.53% and manganese in the range of 40.04%-89.68% using chemical activation, namely Potassium Hydroxide (KOH).

3.4 Relationship Between the Effectiveness of Iron and Manganese Reduction Using the Chi-Square Test

The relationship between the effectiveness of iron and manganese reduction and the thickness and mesh-size variation of banana peel-activated charcoal and coconut shell-activated charcoal is shown in Table 5 below. The data processed below were analyzed using SPSS software.

Table 5. Results of Chi-Square tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (one-tailed)
Pearson Chi-Square	8.000a	1	.005		
Continuity Correction	4.500	1	.034		
Likelihood Ratio	11.090	1	.001		
Fisher's Exact Test				.029	.014
Linear-by-Linear Association	7.000	1	.008		
Number of Valid Cases	8				

a. 4 cells (100.0%) have an expected count less than 5. The minimum expected count is 2.00.
b. Computed only for a 2x2 table
Source: SPSS test results

From Table 5, the Chi-Square test results, we find that 4 cells (100.0%) have expected counts less than 5, indicating that 4 columns have expected counts less than 5; therefore, we can use the Fisher Exact test to make a decision. The Exact Sig. (2-sided) The Fisher Exact Test value is 0.029, which is smaller than 0.05 (0.029 < 0.05). Therefore, it can be concluded that there is a relationship between thickness and mesh and the decrease in iron and manganese levels, so H0 is accepted.

Previous research has shown that banana peel can be used to reduce iron levels (Manurung et al., 2023). Treatment of kepok banana peel with a 30% dose and a contact time of 6 hours resulted in a 69.66% reduction. The results of the two-way ANOVA statistical test showed that the type of banana peel, dose variation, and contact time had an effect on iron reduction

4. CONCLUSION

The results of the study show a significant relationship between media thickness and activated carbon mesh size variation in reducing iron (Fe) and manganese (Mn) concentrations in well water. These findings are supported by laboratory analysis results and absorption effectiveness calculations, which show that changes in media thickness and mesh size affect the adsorption performance of activated carbon. Increasing the thickness of the activated carbon media increases the contact time between water and adsorbents, thereby increasing the opportunity for interaction and more optimal adsorption of Fe and Mn ions. Thus, the thickness of the media and the mesh size of activated carbon are important parameters in improving the efficiency of groundwater treatment processes based on adsorption.

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REFFERENCES

Hamzah, F., Idris, A., & Shuan, T. K. (2011). Preliminary study on enzymatic hydrolysis of treated oil palm (Elaeis) empty fruit bunches fiber (TKS) by using combination of cellulase and β 1-4 glucosidase. Biomass and Bioenergy, 35(3), 1055-1059.

Amna, U., Wahyuningsih, P., & Halimatussakdiah, H. (2019). Penerapan Sistem Filtrasi Tunggal Menggunakan Zeolit Dan Arang Aktif dalam Upaya Penyediaan Air Bersih di Desa Paya Bujok Seuleumak, Kota Langsa, Aceh. *QUIMICA: Jurnal Kimia Sains dan Terapan*, *1*(2), 18-23.

Arifin, Z., Reflis, R., Utama, S. P., Mustopa, M., & Bertham, Y. H. (2022). Variasi Ketebalan Limbah Kulit Ubi Kayu Dan Kulit Durian Untuk Menurunkan Kadar Besi (Fe) Dan Mangan (Mn) Dalam Air Sumur Gali. *Jurnal Sanitasi Profesional Indonesia*, *3*(2), 82-89.

Ariyani, S. B. (2019). Karakteristik bioadsorben dari limbah kulit durian untuk penyerapan logam berat Fe dan Zn pada air sumur. *Jurnal teknologi proses dan inovasi industri*, *4*(1), 23-28.

Asmar, D., Viena, V, & Elvitriana, E. (2021). Aktivasi Karbon Aktif dari Kulit Pisang Awak (Musa Paradisiaca L.) secara Kimiawi dan Aplikasinya pada Adsorpsi Fe dan Mn Air Sumur. *Karya Ilmiah Fakultas Teknik (KIFT)*, *1*(2), 36-46.

Badan Pusat Statistik. (2023). *Statistik Air Bersih 2022*. Jakarta: Badan Pusat Statistik.

Devy, S. D., Miranda, V., Nugroho, W., Magdalena, H., & Hasan, H. (2024). Pemanfaatan karbon aktif tempurung kelapa untuk pemenuhan baku mutu air tanah untuk pH, Mn, dan Fe di Muara Badak, Kutai Kertanegara Kalimantan Timur. *ANDIL Mulawarman Journal of Community Engagement*, *1*(2), 30-34.

Fadhillah, M., & Wahyuni, D. (2016). Efektivitas Penambahan Karbon Aktif Cangkang Kelapa Sawit (*Elaeis guineensis*) dalam Proses Filtrasi Air Sumur. *Jurnal kesehatan komunitas (Journal of community health)*, *3*(2), 93-98.

Hafiz, A. (2023). *Pemanfaatan limbah kulit pisang kepok (Musa acuminate L.) sebagai adsorben dalam penyisihan kadar besi (Fe) dan kadmium (Cd) pada air sumur Desa Lamkeunung Aceh Besar.* Doctoral dissertation, UIN Ar-Raniry Banda

Aceh.

Jusriana, J., Darmawan, D., Duana, M., & Anwar, S. (2023). Analysis of Iron (Fe) Content and PH Content of Protected Well Water in Leubok Village, Aceh Barat District. *Journal of Nutrition Science*, *4*(1), 39-45.

Kementerian Kesehatan Republik Indonesia (Indonesian Ministry of Health). (2023). *Peraturan Menteri Kesehatan Republik Indonesia Nomor 2 Tahun 2023 Tentang Kesehatan Lingkungan*. Jakarta: Kementerian Kesehatan Republik Indonesia.

Manurung, M. N., Fikri, A., Murwanto, B., & Yushananta, P. (2023). Kinerja Beberapa Varian Kulit Pisang Jenis Lokal Terhadap Reduksi Besi (Fe) Dalam Air. *Ruwa Jurai: Jurnal Kesehatan Lingkungan*, *17*(1), 1-7.

Marsidi, N., Hasan, H. A., & Abdullah, S. R. S. (2018). A review of biological aerated filters for iron and manganese ions removal in water treatment. *Journal of Water Process Engineering*, *23*, 1-12.

Ndibale, W., Kadir, A., Wibowo, D., & Ilham, S. (2022). Efektivitas Penyaringan Air Berbasis Kulit Durian Kering Sebagai Media Filtrasi Kadar Logam Berat Kadmium dan Timbal. *Jurnal Geografi, Edukasi Dan Lingkungan (JGEL)*, *6*(1), 36-43.

Nurfitria, N., Febriyantiningrum, K., Utomo, W. P., Nugraheni, Z. V., Pangastuti, D. D., Maulida, H., & Ariyanti, F. N. (2019). Pengaruh konsentrasi aktivator kalium hidroksida (KOH) pada karbon aktif dan waktu kontak terhadap daya adsorpsi logam Pb dalam sampel air kawasan mangrove Wonorejo, Surabaya. *Akta Kimia Indonesia*, *4*(1), 75-85.

Sangadjisowohy, I., & Muhamad, M. T. (2019). Efektivitas Media Arang Batok Kelapa dalam Menurunkan Kadar Salinitas pada Air Bersih di Ake Gaale Tahun 2017. *PROMOTIF: Jurnal Kesehatan Masyarakat*, *8*(2), 147-151.

Saputra, A. W. W., Rubiantoro, P., Asmoro, R., & Artha, V. M. (2024). Water quality enhancement through vertical and horizontal roughing filtration (case study: drilling well at Mojorejo Village, Batu City, Indonesia). In *IOP Conference Series: Earth and Environmental Science* (Vol. 1311, No. 1, p. 012021). IOP Publishing.

Sembiring, H., and Tanjung, N. (2022). "Pelatihan Pembuatan Unit Pengolah Air Sumur Gali yang Mengandung Besi (Fe) dan Mangan (Mn) Menggunakan Metode Kombinasi Klorinasi-Filtrasi dan Zeolit Di Perumahan Milala Desa Namo Bintang Kecamatan Pancur Batu Tahun 2022." *Indonesian Collaboration Journal of Community Services*, 2(4).

Ulfa, M. U., & Sugiri, W. (2023). Kualitas Air Bersih pada Sumur Bor di Desa Sumber Rejo Kabupaten Banyuasin. *Health Care: Jurnal Kesehatan*, *12*(1), 119-127.