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EFFECTIVENESS OF THE FILTRATION METHOD USING ACTIVATED CARBON FROM KEPOK BANANA PEELS AND ZEOLITE TO REDUCE $KMnO_4$ LEVELS

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Abstract. The effectiveness of the filtration method using activated carbon from Kepok banana peels and natural materials such as zeolite has been studied. This research aims to reduce $KMnO_4$ levels in well water so that it can be used for human needs. The well water samples used in the testing process with the filtration method were taken from a well located in Medan Marelan District, Tanah 600 Sub-district, North Sumatra Province. The utilization of Kepok banana peels for activated carbon to reduce $KMnO_4$ levels involved using the chemical activator HCl 3M for 7 hours and an activation temperature of 600°C for 45 minutes. The variations in composition used in the filtration method were sample A (75%:25%), sample B (50%:50%), and sample C (25%:75%). The most effective filtration result in reducing $KMnO_4$ levels was sample A, with a $KMnO_4$ reduction of 86.7%, which meets the clean water quality standards according to PERMENKES RI No 32 of 2017.

Keywords: *Filtration, Activated Carbon, Kepok Banana Peels, Zeolite, $KMnO_4$*
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INTRODUCTION

Indonesia is a country that is predominantly covered by water. Based on the analysis of the International Law of the Sea Convention, known as the United Nations Convention on the Law of the Sea (UNCLOS), the water area of Indonesia reaches approximately 3200 km^2. However, the problem that is still widely discussed today is the lack of availability of clean water [1]. Water is defined as a daily source of life for living beings. The utilization of water in various aspects of life, including bathing, cooking, farming, irrigation, and recreational purposes, is indispensable for essential human needs [2].

The increasing population, particularly in urban areas, has led to a very minimal availability of clean water to meet current needs [3]. There are now many sources of water that are contaminated, including dug well water in the Tanah 600 sub-district of Medan Marelan. The primary cause of contamination in this dug well water is its location near waste disposal sites and animal farming areas. The lack of land, due to human activities that neglect environmental protection, also contributes to the contamination of clean water. Several factors cause the water to turn dark brown and increase the levels of $KMnO_4$, which can be harmful to health. Therefore, efforts are being made to utilize clean water by filtering it with natural additives such as carbon and zeolite to reduce $KMnO_4$ levels in the dug well water [4].

In a previous study conducted by Abdi (2018), the use of activated carbon from plantain peels resulted in a reduction of Mn levels from 11.400 mg/L to 6.2 mg/L [5]. Based on this study, the researcher is conducting an investigation into the effectiveness of the filtration method using activated carbon from plantain peels and zeolite to reduce $KMnO_4$ levels. This study aims to explore the use of a combination of banana peel activated carbon and zeolite in reducing $KMnO_4$ levels and improving overall water quality.

Water

Water can be defined as a chemical compound with the formula H_2O that is essential for the survival of living beings on Earth. Without water, human life cannot be sustained [3]. Water is also a renewable natural resource. However, in reality, the availability of clean water is currently very limited. Generally, the limited availability of clean water is influenced by two factors: natural factors and human factors [6].

Natural factors can be influenced by the geographical conditions that make it difficult to obtain clean water [7]. Human factors can result from industrial factories, improper waste disposal, lack of agricultural land, and other environmental damage caused by human activities [8].

Activated Carbon

Activated carbon is a carbon solid consisting of 85-95% carbon with a surface area of approximately 300-3500 m^2/g on every surface, which is related to the structure of its external pores and functions as an adsorbent [9]. Activated carbon is a black, tasteless, odorless charcoal with high absorbency. In water filters, activated carbon is used for adsorption to remove odors, color, and taste caused by organic substances in the water [10].

The factors affecting the absorbency of carbon include the method of carbon production, the raw material of the carbon, and the surface area of the carbon [11]. The author uses Kepok banana peels because they can reduce Mn levels, especially when the peels are activated with HCl, which can produce optimal absorbency and improve the surface area of the carbon particles [12]. The use of carbon made from plantain peels can reduce $KMnO_4$ levels from 11.400 mg/L to 6.2 mg/L [5].

The quality requirements for activated carbon based on SNI 06-3730-1995 can be seen in Table 1 [13].

Table 1. Quality requirements for activated carbon based on SNI 06-3730-1995

Description	Requirements	
	Granules	Powder
Moisture content	Max. 4.5%	Max.15%
Ash content	Max. 2.5%	Max. 10%
Volatile matter content	Max. 15%	Max. 25%
Carbon content	Min. 80%	Min. 65%

Zeolite

Zeolite is a natural medium used as a material for water purification [14]. Zeolite is one of the most abundant minerals on Earth. It was first discovered by Baron Axel Fredrik in 1756. Zeolite has the ability to absorb water, enhance elements in groundwater, bind organic materials, act as a catalyst for chemical reactions in the soil, and filter molecules. The following is a natural zeolite material used in the filtration method [6].

Zeolite material does not modify its shape, meaning that when heated to high temperatures, it does not change form and is resistant to oxidation and reduction. At a temperature of 600°C, some zeolites do not release ion positions within the crystal and do not cause structural transitions. Zeolite has the following chemical properties: dehydration, filtering or separation, Ion exchange and absorption [14].

Filtration

Filtration is a method of separating or filtering molecules of solids from liquids. The separation of solids and liquids can be achieved using porous media that functions to reduce suspended solids and fine colloids [15]. The quality of the filtered water depends on the pore size of the filter media used. Filtration is a method of removing solids from liquids using porous additional media to reduce as many substances as possible [16]. Filtration can also reduce the content of bacteria, color, manganese, iron, taste, and odor that are usually present in water. Filtration is used as a medium for purifying well water to increase the availability of clean water that can be used for human needs [17].

Kepok Banana Plants

Banana is a monocot herbaceous plant with a pseudostem and a corm at its roots. The lateral shoots (suckers) on Kepok bananas sprout from buds on the corm and then grow into banana plants [18].

Plantain peels contain galacturonic compounds that make them effective at transporting metal ions, as galacturonic acid is a carboxyl functional group [19]. Cellulose also facilitates the binding of heavy metals and contains several biochemical components, including hemicellulose, green pigments, and soluble substances that contain galactose and rhamnose [20].

Chemical Content of Kepok Banana Peels can be seen in Table 2.

Table 2. Chemical Content of Kepok Banana Peels

Elements	Composition (%)
Carbohydrate content	40.74
Crude fiber content	20.96
Cellulose content	17.04
Fat content	16.47
Lignin content	15.36
Moisture content	11.09
Protein content	5.99
Ash content	4.82

RESEARCH METHODS

The method used in this journal is an experimental approach with a quantitative method through filtration utilizing plantain peels with HCl activator. The research equipment required includes containers, a water faucet, jerry cans, filter paper, water hoses, a ruler, transparent pipes, supports, a desiccator, a sieve shaker, a furnace, and an oven. The research materials used include dug well water from the Tanah 600 area of Medan Marelan, zeolite, activated carbon from plantain peels, hydrochloric acid, and distilled water.

The research procedures include:

1. **Preparation of Kepok Banana Peel Carbon.**
   Kepok banana peels are cut, washed, and cleaned with distilled water. They are then dried for 3 days and roasted for 2 hours at a temperature of 400ºC. After cooling, the sample of Kepok banana peel carbon is ready for activation.
2. **Preparation and Testing of Activated Kepok Banana Peel Carbon.**
   Kepok banana peels are heated in a furnace for 45 minutes at a temperature of 600ºC, then cooled, ground, and sieved to 100 mesh. They are then soaked in HCl for 7 hours, filtered, neutralized using distilled water, and oven-dried at 105ºC for 30 minutes. This results in activated charcoal in accordance with SNI 06-3730-1995.
3. **Characterization Stage.**
   Well water samples are taken according to the variations of sample A [75%:25%], sample B [50%:50%], and sample C [25%:75%], then filtered with the test parameter for $KMnO_4$ levels. The characterization test results are compared with the clean water standards according to the Indonesian Ministry of Health Regulation No. 32 of 2017.

RESULT AND DISCUSSION

Physical Testing of Activated Carbon

The results of the physical testing of carbon, including water content, ash content, volatile matter content, and carbon content, are shown in Table 3 below.

Table 3. Physical Testing Results of Carbon

Description	Activated Carbon From Kepok Banana Peels (%)	SNI 06-3730-1995 (%)
Moisture content	6.7	Max. 15
Ash content	6.7	Max. 10
Volatile matter content	15.8	Max. 25
Carbon content	77.5	Min. 65

From Table 3, the results of the physical tests of activated carbon show a moisture content of 6.7%, ash content of 6.7%, volatile matter of 15.8%, and carbon content of 77.5%. These results meet the SNI 06-3730-1995 standards for technical charcoal.

Well Water Results Before Filtration

The test results of well water before filtration are shown in Table 4 below.

Table 4. Results Before Filtration

Test Parameters	Test Results (mg/L)	PERMENKES No. 32 of 2017 (mg/L)
Manganese (Mn)	2.274	0.5
Organic Matter ($KMnO_4$)	65.7	10

Table 4 shows that the well water, with a $KMnO_4$ test parameter value of 65.7 mg/L, does not meet the clean water quality standards of PERMENKES No. 32 of 2017.

Well Water Results After Filtration

The results of well water after filtration for sample variations A, B, and C, showing the $KMnO_4$ organic matter content parameter, can be seen in Table 5.

Table 5. Results After Filtration

Sample	Test Results (mg/L)	PERMENKES No. 32 of 2017 (mg/L)
A	9.8	
B	9.5	10
C	8.7	

Table 5 shows that the well water results after filtration are 9.8 mg/L for sample A, 9.5 mg/L for sample B, and 8.7 mg/L for sample C. These results meet the clean water quality standards of PERMENKES No. 32 of 2017, which is less than 10 mg/L. The $KMnO_4$ test graph can be seen in Figure 1.

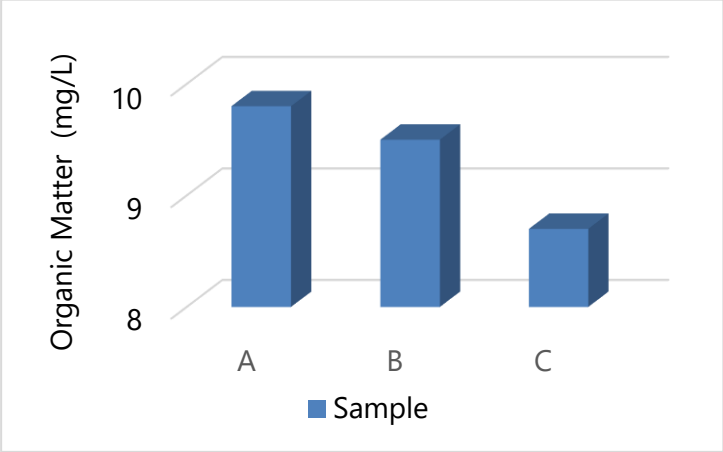

Figure 1. $KMnO_4$ Testing Graph

Figure 1 shows that the addition of zeolite in the filtration process results in a decrease in $KMnO_4$ levels. This is because zeolite acts as an adsorbent, particularly for iron present in well water. The effectiveness of $KMnO_4$ reduction for sample A is 85%, sample B is 85.5%, and sample C is 86.7%. The percentage reduction of $KMnO_4$ meets the clean water quality standards of PERMENKES No. 32 of 2017.

The most effective result in water filtration, which successfully reduced the level of organic substances, was observed in sample variation C (25%:75%) . The $KMnO_4$ value before filtration was 65.7 mg/L and after the filtration process, it was 8.7 mg/L, resulting in a significant reduction with an effectiveness percentage of 86.7%. Therefore, the more zeolite used, the more significant the reduction in $KMnO_4$ levels. However, the presence of activated carbon from banana peels also effectively aids in reducing $KMnO_4$ levels in well water.

CONCLUSION

Based on the research conducted, it can be concluded that the filtration method using activated carbon from kepok banana peels and zeolite is effective in reducing $KMnO_4$ levels in well water. The best composition variation is sample C (25%:75%). The filtration result is 8.7 mg/L, with a reduction percentage of 86.7%, which meets the standards of PERMENKES No. 32 of 2017.

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REFERENCES

[1] E. Walujodjati and Hadi Nurhuda, "Analisis Kebutuhan dan Ketersediaan Air," *J. Konstr.*, vol. 20, no. 1, pp. 183–193, 2022, doi: 10.33364/konstruksi/v.20-1.1053.

[2] R. A. Lomi, J. J. Messakh, and P. G. Tamelan, "Pemanfaatan Air Bersih Untuk

Kebutuhan Rumah Tangga Dari Mata Air Oelnaisanam Di Kelurahan Bakunase II, Kota Kupang," *J. Batakarang*, vol. 2, no. 1, pp. 32–38, 2020, [Online]. Available: https://jurnalbatakarang.ptbundana.org/index.php/batakarang/article/view/52/34

[3] P. Aji, Dimas, Prisilia, and Harliwanti, "ANALISA KEBUTUHAN AIR BERSIH DAN PENGEMBANGAN Jurnal Teknik WAKTU Volume 20 Nomor 01 – Januari 2022 – ISSN : 1412 : 1867 Jurnal Teknik WAKTU Volume 20 Nomor 01 – Januari 2022 – ISSN : 1412 : 1867," vol. 20, pp. 65–72, 2022.

[4] L. A. Harahap, R. Sirait, and R. Yusuf Lubis, "EFEKTIVITAS BIJI KELOR PADA PROSES KOAGULASI UNTUK PENURUNAN KEKERUHAN, LOGAM (Fe), DAN ZAT ORGANIK (KMnO4) PADA AIR," *J. Online Phys.*, vol. 8, no. 2, pp. 66–69, 2023, doi: 10.22437/jop.v8i2.20970.

[5] C. Abdi, R. M. Khair, and M. W. Saputra, "PEMANFAATAN LIMBAH KULIT PISANG KEPOK (Musa acuminate L.) SEBAGAI KARBON AKTIF UNTUK PENGOLAHAN AIR SUMUR KOTA BANJARBARU :Fe DAN Mn," *Jukung (Jurnal Tek. Lingkungan)*, vol. 1, no. 1, pp. 8–15, 2016, doi: 10.20527/jukung.v1i1.1045.

[6] A. Halim Daulay and K. Manalu, "Pengaruh Kombinasi Media Filter Karbon Aktif Dengan Zeolit Dalam Menurunkan Kadar Logam Air Sumur," *JISTech (Journal Islam. Sci. Technol. JISTech*, vol. 4, no. 2, pp. 91–96, 2019, [Online]. Available: http://jurnal.uinsu.ac.id/index.php/jistech

[7] N. Nurfitria *et al.*, "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 Kim. Indones.*, vol. 4, no. 1, p. 75, 2019, doi: 10.12962/j25493736.v4i1.5071.

[8] Y. Trianah and S. Sani, "Keefektifan Metode Filtrasi Sederhana Dalam Menurunkan Kadar Mn (Mangan) Dan (Fe) Besi Air Sumur di Kelurahan Talang Ubi Kabupaten Musi Rawas," *J. Deform.*, vol. 8, no. 1, pp. 90–99, 2023, doi: 10.31851/deformasi.v8i1.11454.

[9] R. Qorina, M. Masthura, and E. Jumiati, "Efektivitas Penurunan Kadar Fe Dan Mn Pada Air Sumur Gali Kelurahan Jati Utomo Kota Binjai Dengan Metode Filtrasi," *J. Redoks*, vol. 8, no. 2, pp. 26–31, 2023, doi: 10.31851/redoks.v8i2.13155.

[10] E. Jumiati, "Refinement of cooking oil using activated carbon from coconut shell and zeolite," *J. Teknosains*, vol. 13, no. 2, p. 152, 2024, doi: 10.22146/teknosains.91766.

[11] N. Nurhidayanti, D. Ardiatma, and B. Anggriawan, "Pemanfaatan karbon aktif dari tempurung kelapa dalam menurunkan kadar amonia total dalam air limbah industri," *J. Pelita Teknol.*, vol. 15, no. 1, pp. 68–76, 2020.

[12] Z. Nst, Y. R. Napitupulu, and Y. C. E. Silalahi, "Peningkatan Kualitas Minyak Goreng Bekas Menggunakan Adsorben Karbon Aktif Arang dari Tempurung Kelapa yang Diaktivasi dengan HCL," *Herb. Med. J.*, vol. 3, pp. 1–5, 2020.

[13] BSN, "Arang Aktif Teknis," *Sni 06-3730-95*, pp. 33–36, 1995.

[14] A. Zulkania, "Pengaruh perlakuan kimia terhadap karakteristik zeolit alam aktif," 2018.

[15] E. Jumiati, E. Pima, and S. Tambunan, "Navigation Physics : Journal of Physics Education Volume 6 Nomor 1 Juni 2024 Peningkatan Kualitas Air Minum Bersumber dari Air Sumur Bor dengan Metode Filtrasi," vol. 6, pp. 55–63, 2024.

[16] O. Karneli, M. Mandataris, S. Sutikno, S. Andri, and ..., "Sosialisasi Transfer

Teknologi dan Pelatihan Pembuatan Filtrasi Air Bersih di Desa Mak Teduh," *Madaniya*, vol. 4, no. 4, pp. 1505–1512, 2023, [Online]. Available: https://madaniya.pustaka.my.id/journals/contents/article/view/578%0Ahttps://madaniya.pustaka.my.id/journals/contents/article/download/578/407

[17] S. C. Palilingan, M. Pungus, and F. Tumimomor, "Penggunaan kombinasi adsorben sebagai media filtrasi dalam menurunkan kadar fosfat dan amonia air limbah laundry," *Fuller. J. Chem.*, vol. 4, no. 2, p. 48, 2019, doi: 10.37033/fjc.v4i2.59.

[18] N. O. K. Sihite, S. Sutarno, D. Parlindungan, H. Johan, and B. Karyadi, "Kemampuan Filter Alami Berbasis Kulit Pisang (Musa paradisiaca L.) dalam Penjernihan Air," *Biosci. J. Ilm. Biol.*, vol. 11, no. 2, p. 1161, 2023, doi: 10.33394/bioscientist.v11i2.9161.

[19] A. S. Madani, W. Prodi, T. Kimia, and F. Teknik, "Pemanfaatan Karbon Aktif Kulit Pisang Kepok Dan Serabut Kelapa Untuk Penurunan Kadar Na Pada Sumur Gali," *J. Multiling.*, vol. 3, no. 4, pp. 1412–482, 2023.

[20] S. Widayana, I. Kurniawati, and S. Susilowati, "Pemanfaatan Limbah Kulit Pisang Kepok Sebagai Bioadsorben pada Penurunan Warna Minyak Bekas Penggorengan," 2022.