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# The Effect of Bamboo Charcoal on pH and Hardware in Dailed Well Water

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**Abstract:** The problem that is often encountered in clean water is that the quality of the water, both groundwater and river water used by the community, does not meet the requirements of healthy clean water. This study aims to determine the effectiveness of activated charcoal from bamboo on pH and decrease the hardness level of dug well water in the village of Lampoh Keude, Aceh Besar. This study used a Quasi-experimental method, water obtained from residents' wells was processed using the filtration and adsorption method, the filtration media was made using media with a volume of 20 liters which had been modified using sand with a thickness of 10 cm, 10 cm of palm fiber, and 10 gravel cm. The highest pH increase test results occurred in TH III AB media where the resulting pH was 7.7 ± 0.01 compared to 4.5 before processing. The same thing also happened to a decrease in the hardness level of residents' well water, where the thickness of the charcoal and the length of contact time greatly affected the test results, from the results of the 3 existing media tests, the best results were obtained by TH III AB media with a contact time of 30 minutes where the level The hardness obtained was 279 ± 3.46 mg/L or a decrease of 47.1% from the initial hardness level of well waste. There is an increase in the pH value of well water after processing, and that the use of bamboo charcoal can also reduce the hardness level of well water.

**Keywords:** Activated charcoal; Bamboo; Hardness

## Introduction

Clean water is needed for human life. Water is said to be clean if: 1. Looks clear 2. Does not smell 3. Has no taste clean water here is defined as water that meets health requirements, be it for drinking, bathing, washing, and so on (Ali et al., 2018). According to (Nasihah et al., 2022), in meeting the need for clean water, appropriate technology can be applied such as making simple filters with various media that can be used, namely, gravel, palm fiber, sand, and charcoal. Bamboo charcoal has the potential to be developed into an environmentally friendly alternative fuel or biofuel. Bamboo trees also function as water purifiers. Therefore, the riverbanks are full of bamboo trees, and the river water looks clear. Water plays a role in carrying non-microbial disease causes such as toxic materials contained therein.

The problem that is often encountered in clean water is that the quality of the water, both groundwater and river water used by the community, does not meet the requirements of clean, healthy water. Water suitable for use is water that meets certain standard requirements such as physical, chemical, and bacteriological. One of the chemical parameters in water quality requirements is the amount of Ca2+ and Mg2+ in water whose presence in water is commonly referred to as water hardness (Harmayani et al., 2021).

Hardness generally indicates the amount of calcium carbonate in mg/L or ppm, based on Permenkes No.492/MENKES/PER/IV/2010 concerning Drinking Water Quality, which is a maximum of 500 mg/l. Hardness can be defined as the property of water caused by the presence of divalent metal ions (cations) which are capable of reacting with soap to form a water scale, the total hardness of water is hardness caused by the presence of $Ca^{2+}$ and $Mg^{2+}$ ions (Rindiani, 2021).

In general society Lampoh Keude Village, Aceh Besar, choose a source water from drilled wells used in everyday life. But the village has peat landmakes the soil acidic and the water becomes colored. It is so worrying because the water contains hazardous metals such as

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copper and sulfate ion. Contains copper and sulfate ions in the potential water cause water pollution very dangerous for living things and environment.

To reduce the hardness of the water in groundwater (wells) a processing method can be used, namely filtration (filtering). Filtration is a way of separating solids from water, while the media used in filtration include quartz sand and bamboo charcoal (Lin et al., 2017). Based on the background mentioned above, in this study researchers will use bamboo charcoal to reduce the level of hardness in dug well water in Lampoh Keude Village, Aceh Besar District.

Previous researchers reported that the use of hard water for a long time can cause kidney problems due to the accumulation of CaCO3 and MgCO3 deposits. Water containing $Ca^{2+}$ and $Mg^{2+}$ that exceeds quality standards is not recommended for people who have poor kidney function because it causes kidney stones (Mitra et al., 2018). This research examines dug well water which is one of the community's alternatives in anticipating a reduced supply of drinking water provided by the PDAM. Dug well water is susceptible to pollution because of poor good construction and a depth of fewer than 15 meters, which allows contaminants to enter the well (Dalmieda et al., 2019).

Dug wells provide water that comes from a shallow groundwater layer from an unsaturated zone, therefore it is easily contaminated through seepage so it has the potential to decrease water quality. It is feared that there will be a decrease in the quality of well water due to poor sanitation, such as seepage of household wastewater, chemical waste, laundry, and others. The most common contamination is due to water runoff from human or animal waste disposal facilities, which originate from septic tanks that are less permanent (Kustanto, 2020). The purpose of this study was to determine the effectiveness of activated charcoal from bamboo on pH and a decrease in the hardness level of dug well water in the village of Lampoh Keude, Aceh Besar.

## Method

This research is a Quasi-experimental study, according to (Hikmawandini et al., 2017) measurements of the subjects were carried out before and after being given treatment. then look for the difference between the results of the two measurements. The differences that emerged were then considered as a result of the treatment.

*Making Bamboo Charcoal*

Bamboo stalks were cut to a size of 10 cm, washed with running water, and then dried in an oven at 150°C. After drying, the dry bamboo sticks are carbonized using a furnace at 500°C for 1 hour, then cooled, then reduced in size.

*Bamboo Charcoal Activation*

The charcoal that has been formed is activated using 5% NaOH, soaked for 48 hours, then filtered and rinsed with distilled water. Then the soaked charcoal that has been rinsed is dried again until a constant weight is obtained.

*Characterization of Activated Charcoal (Iodine Absorption)*

Weighed as much as 0.2 g of activated bamboo charcoal and then put it into an Erlenmeyer then added 25 mL of 0.1 N iodine solution and stirred, after mixing the mixture then centrifuged to form two layers. 10 mL of the supernatant was then put into the Erlenmentry, then titrated with sodium thiosulphate solution using 1% starch indicator, until the blue color disappeared.

*Water Samples and Filtration Media*

The water samples in this study were taken from residents' wells in the village of Lampoh Keude, Kuta Baro District, and Aceh Besar District. Furthermore, the water obtained from the well is treated using the filtration and adsorption method, the filtration media is made using a pipe with a size of 3 inches that has been modified using sand with a thickness of 10 cm, 10 cm of palm fiber, and 10 cm of gravel. then the absorption media device is made using a 4-inch pipe and filled with charcoal from bamboo sticks with thicknesses varying from 5 cm, 10 cm, and 15 cm. The composition and thickness of each media are shown in the following Table 1.

**Table 1**. Composition of Materials in Filtration and Absorption Media

| Media code | No Media | Material | Thickness (cm) |
|---|---|---|---|
| | | Gravel | 10 |
| TH 1 AB | Filtration | Fibers | 10 |
| | | Sand | 10 |
| | Absorption | Charcoal | 5 |
| | | Gravel | 10 |
| TH II AB | Filtration | Fibers | 10 |
| | | Sand | 10 |
| | Absorption | Charcoal | 10 |
| | | Gravel | 10 |
| TH III AB | Filtration | Fibers | 10 |
| | | Sand | 10 |
| | Absorption | Charcoal | 15 |

In each medium, the thickness of the charcoal used varies, namely 2, 10, and 15 cm. The aim is to determine the effect of the thickness of the charcoal on the purification process of wastewater samples. The composition of the ingredients in the media is charcoal which is in the lowest layer, followed by sand, and gravel and the top layer is palm fiber with a thickness composition according to what has been mentioned in Table 1.

## Result and Discussion

The process of activating the charcoal is carried out chemically (Aryani, 2019), where the charcoal is soaked in a chemical solution, in this study the carbonated bamboo sticks were soaked in a 5% NaOH solution. After the activation process of the bamboo charcoal was completed, the characterization of the charcoal was carried out by measuring the absorption capacity of the activated charcoal against the iodine solution, based on the measurement results it was known that the absorption capacity of the activated charcoal towards the iodine solution was 984.6 mg/g. Based on these results, it can be concluded that the bamboo charcoal has been activated and can then be tested on water samples that have been prepared.

pH degree in this study, well water originating from residents' wells in the Lampoh Keude Village area, Kuta Baro District, Aceh Besar, was treated using filtration media and bamboo charcoal absorption media. The duration of contact between water samples and bamboo charcoal varies from < 1 minute, 10 minutes, 20 minutes, and 30 minutes. The acidity level of the water is then measured using a pH meter. The measurement results are shown in Table 2.

**Table 2.** Results of pH Measurements of Well Water Samples

| Media | Contact Time (minutes) | pH degree (n=3) | Quality Standards (SNI 05-6989.11-2019) |
|---|---|---|---|
| | Before Processing | 4.5±0.02 | |
| | <1 | 5.1±0.21 | |
| | 10 | 5.9±0.04 | |
| TH 1 B | 20 | 6.5±0.05 | |
| | 30 | 6.8±0.02 | |
| | <1 | 5.3±0.02 | |
| | 10 | 6.3±0.02 | |
| TH II B | 20 | 6.8±0.03 | |
| | 30 | 7.2±0.02 | |
| | <1 | 5.3±0.02 | |
| | 10 | 6.3±0.02 | |
| TH 3 B | 20 | 6.5±0.05 | |
| | 30 | 6.8±0.02 | |

Based on the data shown in Table 2, it is known that there is a significant difference in the degree of pH before and after processing well water. The pH of the well water before being treated was 4.5, the pH measurement results after being treated also varied depending on the thickness and duration of contact with the bamboo charcoal in the absorbing medium. Based on the results: From the measurement, it can be concluded that the degree of pH is largely determined by the length of contact time and the thickness of the charcoal, based on the test results the best results were obtained from bamboo charcoal media with a thickness of 15 cm and a contact time of 30 minutes, where the resulting pH degree was 7.7 ± 0.01. Supported by the theory from (Joharwan et al., 2020).

The standard degree of water pH is based on Permenkes No. 492/MENKES/PER/IV/2010 Concerning Drinking Water Quality, namely 6.5–8.5. This condition is the same as the results of research conducted by (Addisie, 2022) using three media namely sand, activated carbon, and zeolite in the filtration method can increase water quality for pH, while reducing Fe, reducing turbidity. The results of other studies show that there is a significant effect of the use of filter combinations on increasing the pH of well water (Cescon et al., 2020). The use of thick filters, this type of filter can improve water quality. It is hoped that the variation in the thickness of the double-decker filter will better improve water quality, as well as a tool for treating well water (Mulhern et al., 2020). The filtration process in this study uses palm fiber media, gravel, and sand. Then for adsorption media using activated charcoal and zeolite, It is supported by (Khaerudin et al., 2021).

The increase in the degree of acidity (pH) of water in this study probably occurred because during the process of filtration and adsorption of metal compounds contained in the water had decreased. In the filtration process, the sand, palm fiber, and stone media used have pores and gaps that can absorb and retain particles in water. In the adsorption process using activated charcoal and zeolite media can bind cations in water such as iron (Fe), aluminum, or magnesium. So that by reducing the metal compounds in it, it will have an impact on increasing the degree of acidity of the water (Saalidong et al., 2022). Water Hardness: Water that has been treated using the media that has been prepared, then the water hardness level is measured using the EDTA titrimetry method (Yan et al., 2022), the results of the hardness level measurement are shown in Table 3.

**Table 3.** Results of Decreasing the Hardness Level

| Media | Contact Time (minutes) | Hardness (mg/L) (n=3) | Decreasing (%) | Quality Standard |
|---|---|---|---|---|
| Before Processing | | 527±2.35 | - | |
| | < 1 | 512±1.71 | 2.8 | |
| | 10 | 486±1.38 | 7.8 | |
| TH 1 AB | 20 | 441±2.15 | 16.3 | |
| | 30 | 394±2.23 | 25.2 | |
| | < 1 | 489±1.84 | 7.2 | |
| | 10 | 436±1.38 | 17.3 | (SNI 06-6989.12-2004) =500 |
| TH II AB | 20 | 378±2.45 | 28.3 | |
| | 30 | 327±2.33 | 38.0 | |
| | < 1 | 473±2.64 | 10.2 | |
| | 10 | 386±1.87 | 26.8 | |
| TH III AB | 20 | 318±2.44 | 39.7 | |
| | 30 | 279±3.46 | 47.1 | |

Based on the data in Table 3 it is known that there is a change in the level of water hardness after processing using the media that has been made, the level of water hardness differs depending on the thickness of the bamboo charcoal used and also the length of time the water is in contact with the bamboo charcoal. On TH I AB media, the long contact time decreased the level.

The most significant hardness was the contact time of 30 minutes where the resulting hardness level was 3944 ± 2.23 mg/L from the previous hardness value of 527 mg/L, this indicates a decrease in the hardness level of 25.5%. The reduction in the hardness level of the resulting water meets the established water quality standard of 500 mg/L. Similar results were also shown in TH II AB media, where the most significant decrease in hardness level was the result of processing the contact duration of the water sample with bamboo charcoal for 30 minutes, the resulting hardness level was 327 ± 2.33 mg/L, meaning a decrease of 38.0%. on TH III AB media, the water hardness level at 30 minutes of contact time was 279 ± 3.46 mg/L, where there was a decrease of 47.1%. The comparison of hardness reduction is shown in the following Figure.

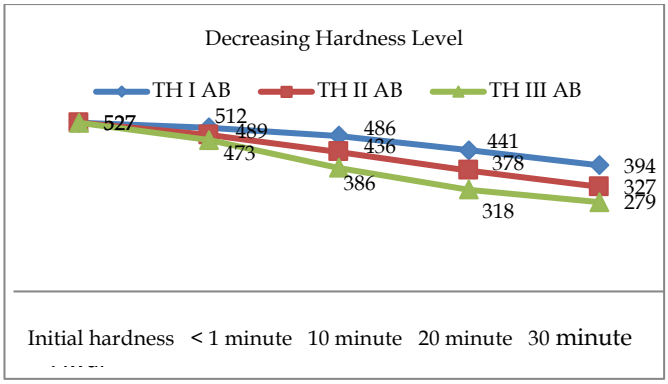


**Figure 1**. Comparison of Hardness Reduction in 3 different media and at different contact times

Based on the results of the tests that have been carried out, it can be concluded that the decrease in the hardness level is determined by the thickness of the charcoal as the absorption medium and the length of contact time, where the longer the contact time, the lower the hardness level of the resulting water. The difference in the length of contact disaffection decreases the level of water hardness in the filtration and absorption processes. Filtration or filtering is the initial process in water treatment which is carried out physically to separate particles in water (Farah et al., 2019). In this filtration process, there is a process of separating solids from the solution to remove very fine suspended particles, where the solution is passed through a porous medium or porous material. This process is used in drinking water treatment plants to obtain good water quality (Fitobór et al., 2021).

After the filtration process is carried out, the adsorption process is carried out. Adsorption is a separation process in which certain components in the fluid phase move to the surface of a solid which has adsorbent properties. The adsorption process carried out in this study used bamboo charcoal. In the adsorption process, there is a separation of aromatic compounds and dissolved compounds, (Lamaming et al., 2022). The adsorption process can be defined as a process in which molecules leave the solution and attach to the surface of bamboo charcoal as an adsorbent as a result of chemical and physical bonds (Al-Muttair et al., 2022). If the attractive force between the molecules of the solute and the adsorbent is greater than the attractive force between the molecules and the solvent, the solute will be adsorbed. In addition, the length of contact time will affect reducing hardness because the longer the adsorption process takes place, the more hardness-causing substances can be bound by bamboo charcoal (Nurhayati et al., 2021)

The results of this study are in line with research conducted by (Büker et al., 2021) which shows that there is an effect on the level of water hardness after the filtration process is carried out. The percentage of decrease in contact time was 10 minutes (25.23%), 20 minutes (36.44%), and 30 minutes (56.38%). Using water with high hardness for a long time can also cause kidney problems which is the effect of the accumulation of CaCO3 and MgCO3 deposits. This is supported by research conducted by (Widodo et al., 2020), based on research results it is known that there is a relationship between the hardness level of dug well water (p-value = 0.001) and the incidence of kidney stones in the community in the work area of the Margasari Health Center. The results showed that dug well water with high hardness was a risk factor for kidney stone disease (OR = 4.795). Mallik et al. (2019) reported that the hardness level in the drinking water of people with urinary tract stone disease was 1375.172 mg/l, greater than the hardness level of drinking water sources for those who were not suffering from urinary tract stone disease which was 429.7415 mg/l.

Provisions regarding water hardness are regulated in Permenkes No.492/MENKES/PER/ IV/2010 concerning Drinking Water Quality, namely a maximum of 500 mg/l. (Mikosch et al., 2021) states that water with a high hardness level or that exceeds a threshold value when consumed without prior processing will result in various health problems. The impacts of hard water on health include causing cardiovascular disease (blockage of the heart arteries) and urolithiasis (kidney stones) (Cormick et al., 2020).

## Conclusion

Based on the results of the research that has been done, it can be concluded that there is an increase in the pH value of well water after processing, besides that the use of bamboo charcoal can also reduce the hardness level of well water. The increase in the pH value and the decrease in the hardness level are affected by the thickness of the charcoal and the length of contact time, where the thicker the charcoal and the longer the contact time, the higher the level of decrease in the hardness of the well water.

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