



Effectiveness Of Corn Cob Charcoal Powder To Reduce Iron (Fe) Levels In Dug Well Water East Dulalowo Village

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Article Info

Article history:

Received 09 Feb, 2026

Revised 27 Mar, 2026

Accepted 17 Apr, 2026

Keywords:

Effectiveness, Corn Cob, Iron Content, Dug Well Water

ABSTRACT

Dug well water is one of the sources of clean water that is used by the community as a water supply facility in daily life. However, the water quality of dug wells often does not meet the requirements, especially in chemical parameters, especially iron content (Fe). High iron levels in water can reduce water quality and increase health and economic problems, so effective, safe and environmentally friendly water management efforts are needed. Corn cobs can be used as activated carbon which acts as a bioadsorbent against iron ion (Fe) pollution. This study aims to test the effectiveness of corn cob charcoal powder in reducing iron (Fe) levels in dug well water with variations in corn cob dosages of 10 grams, 15 grams and 20 grams.

The type of true experimental research with a pre-test-post test approach. Iron levels were determined using the spectrophotometry method with three repetitions. Data were analyzed using the Kruskal Wallis test ($\alpha = 5\%$).

The results of the study showed that the decrease in iron content in the water of the dug well after treatment with a dose of 10 grams with an average value of 0.2341 Mg/L, a dose of 15 grams with an average value of 0.1859 Mg/L, and a dose of 20 grams with an average value of 0.2076 Mg/L This study shows that corn cob charcoal powder is effective in reducing iron levels in dug well water and the dose of corn cob charcoal powder that is effective in reducing iron (Fe) levels in dug well water is the dose 15 grams with a p-value of $0.026 < 0.05$, iron content reaches 0.1859 Mg/L and the effectiveness reaches 82%. It is suggested that the community can use corn cob waste as an adsorbent in reducing iron levels and modifying the management of corn cob waste.

INTRODUCTION

Water is the most needed element of the earth for the survival of living things. Water is also a substance of life, The abundant availability of water in Indonesia does not necessarily meet the water needs in each region because the type of water that dominates is salt water so it is not suitable for use in meeting water needs (Widodo, 2023).

Indonesia is a region that uses various kinds of clean water sources, namely surface water, rainwater, groundwater, and springs. The Indonesian people most often use groundwater in the form of dug wells as a source of meeting clean water needs in daily life. Dug well water is very easily contaminated by bacteria that come from waste or human waste. The hardness of groundwater results in the production of water that has a high mineral content. These minerals include calcium, magnesium, and heavy metals in the form of Fe (Baktiar, Sahdan, & Setyobudi 2022).

Exposure to heavy metal iron (Fe) in the human body can be through direct contact with the skin or orally and enter the digestive system, the impact of exposure to water containing iron (Fe) chemicals is irritation to the eyes and skin, if consumed can cause symptoms of nausea and can even damage the walls of the small intestine which ends in death (Fadillah, Ganish Eka, 2022).

According to Halim, Romadon, & Achyar (2022) that the adsorption method is the most appropriate step compared to the other steps. Adsorption usually uses carbon absorbing materials. The content of heavy metals in water such as iron can be reduced by an adsorption process that utilizes activated carbon (Safitri & Kristianingrum, 2020).

Corn cobs are one of the materials that have quite potential to be developed because of their abundant source of raw materials. Corn cobs contain lignin (6%), cellulose (41%), and hemicellulose (36%) which are high enough that they have the potential to be used as an adsorption material. Gorontalo is one of the largest corn-producing provinces in Indonesia, dubbed as the "National Corn Barn". Corn cob waste is usually just thrown away so that it accumulates in large quantities. Therefore, it is necessary to manage corn cob waste as activated carbon to add economic value.

Regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2023 Water Quality Standards for Hygiene and Sanitation Purposes, namely the chemical content of heavy metal iron (Fe) in water is a maximum of 0.2 mg/L. The high iron content contained in the water of the dug well in East Dulalowo Village, if directly observed, is caused by several factors, in the form of environmental conditions such as the distance between the well and the latrine that does not meet the Indonesian National Standard, depth of the well, surface contamination, local geological characteristics of East Dulalowo Village located adjacent to the rice field area and environmental pollution carried out by the community as well as, throwing garbage out of place, not having a household SPAL, these factors can pollute soil nutrients so as to increase the high iron level in the water of the dug well (Yudhastuti & Arifani, 2013).

The purpose of this study was to determine the effectiveness of corn cob charcoal powder in reducing iron (Fe) levels in dug well water in East Dulalowo Village, Kota Tengah District, Gorontalo City.

RESEARCH METHODS

This research was conducted from December 2025 to January 2026 The sampling location was in East Dulalowo Village. The location of the treatment and testing of samples at the Chemistry Laboratory, Gorontalo State University. The type of research used is true experimental design with pre-test design, post-test control group design, pre-test before treatment and post test after treatment with corn cob charcoal powder at doses of 10 gr, 15 gr and 20 gr. The sampling technique is grab sampling. Data analysis used non-parametric tests, namely the Kruskal Wallis test and the follow-up test (Post Hoc test) to determine the difference between doses.

Results

Iron (Fe) content in dug well water with variations in the dosage of corn cob charcoal powder of 10 grams, 15 grams and 20 grams.

Table 1 Analysis Results of Dug well water samples on Turbidity parameters

Parameters	Dosage (mg)	Repetition			Average (mg/L)	Effectiveness (%)	Quality Standard < 3 NTU
		I	II	III			
Iron Levels (Fe)	Controls	1,005	1,005	1,005	1,005	-	Not meeting standards
	10 gr	0,2358	02308	0,2358	0,2341	76,7	Not meeting standards
	15 gr	0,1810	0,1859	0,1859	0,1859	82	Meet standards
	20 gr	0,2109	0,2059	0,2076	0,2076	79,3	Not meeting standards

Source: Primary Data, 2025

Based on table 1, it can be seen that before treatment on the dug well water sample at the starting point (control), the iron content value was 1.005 Mg/L at the control point, the results obtained did not meet the standards of the Minister of Health Regulation Number 2 of 2023 that the standard iron content in water was <0.2 Mg/L. The value after being treated with each dose of corn cob charcoal powder of 10 grams, 15 grams and 20 grams, where in each dose of corn cob charcoal powder there was a decrease in iron (Fe) levels and the dose that showed a significant decrease was found in the treatment with a dose of 15 grams with an average value of 0.1859 Mg/L The results obtained met the standard of clean water quality, namely iron content < 0.2 Mg/L with a percentage of 82% while at a dose of 10 grams of corn cob charcoal powder

obtained an average value of 0.2341 Mg/L obtained does not meet quality standards. The magnitude of the decrease in iron (Fe) levels in the dug well water can be seen in the figure below.

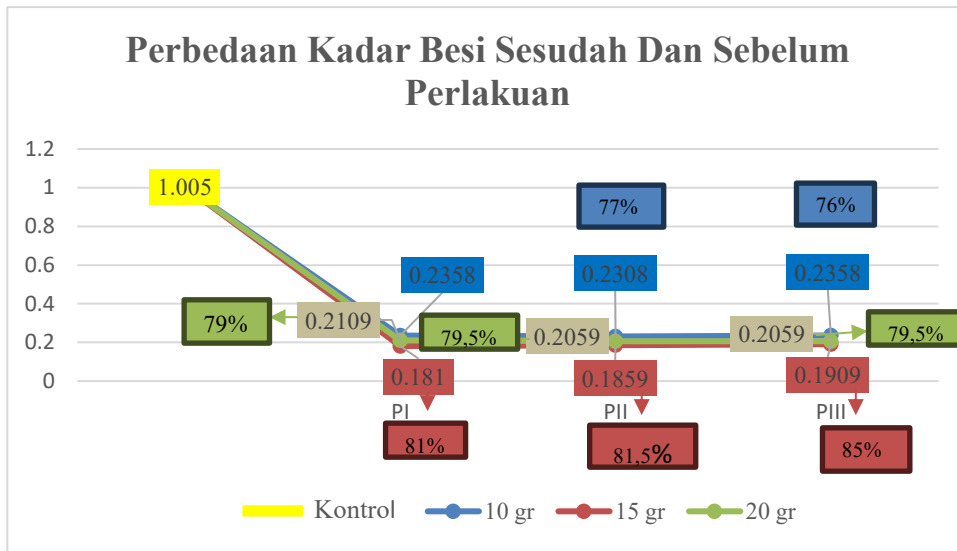


Image 1 Graph of Iron Levels (Fe) before and after treatment
Source: Primary Data, 2025

Description:

- PI : Repetition I
- PII : Repetition II
- PIII : Repetition III

Based on Figure 1, the graph shows a change in iron content (Fe) value in dug well water before and after treatment using corn cob charcoal powder with a dose variation of 10 grams, 15 grams and 20 grams. Based on the graph, it can be seen that the initial iron level (Control) was 1.005 Mg/L then after being treated with dug well water experienced a significant decrease in all treatments. A dose of 10 grams yields an average iron content value of 0.2341 Mg/L, a dose of 15 grams has an average value of 0.1859 Mg/L and a dose of 20 grams has an average value of 0.2076 Mg/L.

The lowest iron (Fe) content value was found at a dose of 15 grams, with an average value of 0.1859 Mg/L from the result that met the quality standard of < 0.2 Mg/L, this shows that this dose is the most effective dose in reducing iron (Fe) levels in dug well water compared to other doses. This identifies that at a dose of 15 grams the adsorption process occurs more effectively resulting in a greater decrease in iron levels.

Analysis of Difference in Dose Effectiveness (10 gr, 15 gr and 20 gr) of corn cob charcoal powder on iron content in dug well water

Data Normality Test

Table 2 Data Normality Test

Parameters	Corn Cob Charcoal Powder Dosage Treatment	p-value
Iron (Fe)	Dosage 10 grams	0.000
	Dosage 15 grams	0.989
	Dosage 20 grams	0.000

Source: Primary Data 2025

Based on table 2, it is known that the results of the normality test of iron parameter data using the Shapiro-Wilk test obtained a p-value of > 0.05 at a dose of 15 grams while at doses of 10 grams and 20 grams the data was not distributed normally, so using a Non-Parametric Test, namely the Kruskal Wallis test.

Variance Homogeneity Test

Table 3 Data Homogeneity Test

Parameters	<i>p-value</i>
Iron (Fe) Levels	0.712

Source: Primary Data, 2025

Based on the table, it is known that the p-value of the Iron (Fe) content is $0.712 > 0.05$. So it can be concluded that the data has the same variant

Kruskal Wallis Test

Table 4 Kruskal Wallis Test

Parameters	Variable	<i>p-value</i>
Iron (Fe) Levels	Dosages are 10 grams, 15 grams, and 20 grams.	0.026

Source: Primary Data, 2025

Based on table 4, it shows that the p-value is $0.026 < 0.05$. So it can be said that there is a significant difference between the dose groups of corn cob charcoal powder and the iron content in the water of the dug well. This shows that the variation in the dose of bioadsorbents affects the effectiveness of reducing iron (Fe) levels in dug well water.

Further Test (Post Hoc Bonferroni)

Table 5 further test (Post Hoc Bonferonni)

Dosage	Dosage	<i>p-value</i>
10 Grams	15 Grams	0.000
	20 grams	0.000
15 Grams	10 Grams	0.000
	20 grams	0.001
20 grams	10 Grams	0.000
	15 Grams	0.001

Source: Primary Data, 2025

Based on table 5, it can be seen which dose groups have significant differences, The test results show that there is a significant difference between the 10 gr and 15 gr doses with a p-value of 0.000, between the 10 gr and 20 gr doses with a p-value value of 0.000 and between the 15 gr and 20 gr doses with a p-value of 0.001. All of these p-values are less than 0.05, which indicates that each dose variation has a noticeably different effect on iron (Fe) concentration.

DISCUSSION

Iron content in dug well water with a dose of corn cob charcoal powder of 10 grams, 15 grams and 20 grams

Based on the results of the study, iron content values in dug well water were measured before the treatment of the starting point (Control), which was 1.005 Mg/L. The results obtained did not meet the requirements of the Minister of Health Regulation No. 2 of 2023 which sets the standard for clean water quality with iron content of <0.02 Mg/L. Iron (Fe) content after being treated using a dose of 10 grams of corn cob charcoal powder, an average result of 0.2341 Mg/L was obtained. with an effectiveness of 76.7%, those who used a dose of 15 grams obtained an average reduction of 0.1859 Mg/L, with an effectiveness of 82%, those who used a dose of 20 grams obtained an average reduction of 0.2076 Mg/L with an effectiveness of 79.3%. Based on the results of this study, the dose of 15 grams of corn cob charcoal powder was the most effective in reducing iron levels in the water of the dug well, the result obtained was 0.1859 Mg/L which met the quality standard standard. Meanwhile, at doses of 10 grams and 20 grams of corn cob charcoal powder, it is still above the standard value of clean water quality.

The value of iron content (Fe) before treatment is very high due to the physical conditions of the well which allow the entry of pollutants from the environment around the well. The well is in an open area and the distance between the septic tank is not far from the location of the dug well and the depth of the well

affects chemical contamination from the ground. In addition, the existence of rice fields and surrounding vegetation causes water runoff on the ground surface to bring suspended particles into the well. Other factors such as the proximity of the distance between the septic tank and the existence of wells also have the potential to increase the pollution burden through groundwater seepage. In addition, the well can also be the cause of high iron levels in the water of the dug well. This is in line with research (Amaliah, 2020) which states that the depth of the well that is not too deep can be a factor causing the low iron content in the water of the dug well, in addition to the location of the well adjacent to the river or darainase may be the cause of the high iron content in the water, the technical disturbance of the sediment (Fe) is corrosive to the pipeline and will settle on the pipeline, resulting in killing and harmful effects such as soiling the basin made of zinc. Dirty sinks and toilets and the presence of iron in the water can cause the water to become colored, smelly and tasteful.

The decrease in iron levels after going through the adsorption process using corn cob charcoal powder shows that the material is effective in acting as a natural bioadsorbent. Corn cob charcoal powder contains various components that have the potential to cause a decrease in iron levels in dug well water, namely the content of lignin (6%), cellulose (41%), and hemicellulose (36%) which is quite high, indicating that corn cobs have the potential to be a material for making charcoal cellulose content has functional groups such as carboxyl groups and hydroxyl groups that can bind metal ions. This is in line with research (Rakhmania et al., 2017) which states that cellulose, hemicellulose and lignin, where the functional groups in the cellulose chain are hydroxyl aliphatic groups (R-OH), and hemicellulose has hydroxyl and carboxyl aliphatic groups, while lignin has various functional groups including aliphatic and aromatic hydroxyl groups. Groups such as hydroxyl and carboxyl can be used to adsorb metal cations.

In addition, the activation of corn cob carbon can also affect the decrease in iron levels in water, the activation of corn cob carbon aims to remove impurities present in the pores of activated carbon by breaking hydrocarbon bonds or by oxidizing compounds found on the adsorbent surface Mohd Hilal Assegaf (2024). The absorption will be higher if the carbon is chemically activated (Rahayu, Antonia Nunung, 2014).

Based on the results of the study, a dose of 10 grams has the ability to reduce iron (Fe) levels in dug well water by 76.7% with an average value of 0.2341 Mg/L at this dose, the results obtained do not meet quality standards. This is in line with research Riskawati, (2019) which states that a concentration of 10 grams can reduce iron (Fe) levels by an average of 1.05 mg/l by a percentage of 58%. At low doses such as 10 grams, the number of available pores is not large enough to increase the iron metal ions in the dug well water so that the effectiveness of reducing iron levels in the dug well water is low and not optimal. The greater the amount of charcoal concentration, the higher the rate of decrease in iron (Fe) content (Yudhastuti & Arifani, 2013).

Based on the results of the study, the 15-gram dose is the most effective dose with a percentage reduction of 82% and produces an iron content value of 0.1859 Mg/L, the value produced has met the standard for clean water quality according to the Minister of Health Regulation No. 2 of 2023 iron content standard <0.02 Mg/L. This is in line with research Riskawati, (2019) which states that at a concentration of 15 grams can reduce iron (Fe) levels by an average of 1.5 mg/l by a percentage of 82%. According to Abibah, Nurul Aisyah, Nurulmutiah Rahmah Ramadhana, Ummu Kalsum, (2025) The increase in the dose of adsorbents causes an increase in surface area and the number of active sites so that the process of adsorption of Fe ions from dug well water takes place more optimally. In addition, the decrease in iron (Fe) levels at each dose was caused by carbonated and activated corn cob charcoal. This is because the chemical activation process plays a role in opening the pores of the adsorbent and increasing the active functional group on the surface of the charcoal, so that iron ions (Fe) can be bound through the adsorption mechanism (Purbarindi, Nunik, 2019).

Meanwhile, at a dose of 20 grams, it showed an effectiveness of reducing iron (Fe) content by 79.3% and the resulting value of 0.2076 Mg/L, this value did not meet the standard standards of clean water quality, besides that the effectiveness at a dose of 20% was lower than at a dose of 15%. According to Purbarindi, Nunik, (2019) That the mass of the adsorbent is one of the factors that affect the adsorption process, where the more adsorbents used, the more adsorbate can be absorbed. However, if the adsorbent mass given is excessive, then adsorbent is not effective for the absorption process. This is because the excess amount of adsorbents can fill the surface of the adsorbate, so that the increase in mass will cause the adsorbent to reach the saturation point and absorption does not occur optimally (Alfiyatun & Kristianingrum, 2025).

Analysis of the difference in dose effectiveness (10 grams, 15 grams and 20 grams) of corn cob charcoal powder on iron (Fe) content in dug well water

Based on the results of the study, there is a difference in the effectiveness of the use of corn cob charcoal powder as a bioadsorbent on iron (Fe) levels. The difference in the dosage of corn cob charcoal powder has a different effect on the decrease in iron (Fe) content in the water of the dug well. The mass of the bioadsorbent affects the level of effectiveness. This happens because the more mass of the adsorbent the

number of pores and active sites available increases to bind Fe ions from the liquid phase to the adsorbent surface. This condition causes an increase in adsorption ability until it reaches the optimal point.

Based on the results of data analysis, it showed that there was a difference in effectiveness between the dose of 10 grams, 15 grams and 20 grams of value (p -value = 0.026). The p -value of < 0.05 shows that there is a difference in the effectiveness of reducing iron (Fe) levels between the three doses. The results of the test explained that the variety of dose variations had a real effect on the effectiveness of reducing iron (Fe) levels. So to see the difference in the effectiveness of each dose, do a follow-up test, namely a Post Hoc test to determine which group gives a difference.

The results of the Post Hoc analysis showed that there was a significant difference between the doses of 10 grams, 15 grams and 20 grams. Of the three doses, the p -value of < 0.05 has a p -value, which indicates that the difference in adsorbent doses has a significant effect on the ability to reduce iron levels in dug well water.

A comparison between the 10 gram and 15 gram doses showed p -value 0.000 which means there is a difference in iron levels after treatment. The average difference value showed that iron levels at a dose of 15 grams were lower than at a dose of 10 grams. This identifies that an increase in the dose of 15 grams of adsorbent is able to bind iron ions (Fe) so that the adsorption process takes place more optimally. This is in line with research Riskawati, (2019) which states that the use of biomass-based adsorbents with a dose of 15 grams effectively reduces Fe levels in borewell water. The dose is considered quite optimal because it is able to significantly reduce Fe levels without causing rapid adsorbent saturation. This shows that intermediate doses can provide good adsorption efficiency

The results of the comparison between the 15 gram and 20 gram doses also showed a significant difference in the value of the P -Hairy 0.001. However, the average value showed that increasing the dose of corn cob charcoal powder from 15 grams to 20 grams did not result in a more effective reduction in iron levels. This condition can be caused by the occurrence of adsorbent saturation, where part of the surface of the charcoal has been covered by Fe ions, so that the addition of adsorbents no longer significantly increases the absorption efficiency. This is in line with research Alfiyatun & Kristianingrum, (2025) which states that the amount of adsorbents affects the adsorption process if the surface is filled with adsorbate, then the increase in mass will cause the adsorbent to reach the saturation point.

CONCLUSION

Based on the results of the research that has been carried out, it can be concluded that the iron (Fe) content in the water of the excavated well in East Dulalowo Village, Kota Tengah District with a dose of 10 grams with an average value of 0.2341 Mg/L, a dose of 15 grams with an average value of 0.1859 Mg/L, and a dose of 20 grams with an average value of 0.2076 Mg/L.

The dose of corn cob charcoal powder that is effective in reducing iron (Fe) levels in the water of the excavated well is a dose of 15 grams, with a p -value of $0.026 < 0.05$, with iron content from 1.005 Mg/L to 0.1859 Mg/L with an effectiveness of 82%.

SUGGESTIONS

For the community, it is recommended to use corn cob waste which is usually only a pile of garbage and accumulates as a source of disease if it can be processed into more useful materials such as charcoal powder which can be used as an adsorbent in reducing iron levels, filtration and others. In addition, the next researcher also needs to modify corn cob waste naturally to remain environmentally friendly and be able to compare the effectiveness of plant-based and synthetic adsorbents.

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