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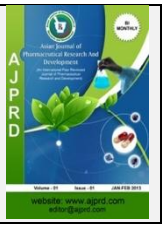

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Research Article

Utilization of shell waste as an adsorbent to reduce Fe (Iron) Metal

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A B S T R A C T

Background: So far, clam and crab shells have only been used for handicrafts such as wall hangings, or for animal feed mixtures. Shellfish shell waste contains high calcium carbonate, which is 98%, which has the potential to be utilized. Based on the results of previous studies on clam shell powder, the results were quite good at absorbing heavy metals. This research exploits the potential of shellfish in another form, namely shell ash as an alternative adsorbent that is environmentally friendly, because shell ash consists of compounds namely 7.88% SiO2, 1.25% Al2O3, 0.03% Fe2O3, 66.70% CaO, and 22.28% MgO. Based on the chemical composition, the CaO content in the shell ash is quite high so that the shell ash has the potential as an adsorbent. Purpose: to determine the ability of clam shells as an Fe adsorbent. Method: This type of research is quasi-experimental in nature, which is a research method that uses a quantitative approach, carrying out three control activities, manipulating activities and observation. In this study the researchers treated water containing Fe using blood clam shells and green mussel shells, as adsorbents. Results: Based on these results it can be seen that there is a decrease in iron (Fe) content by using variations in the size of clam shell granules as an adsorbent. The smaller the size of the clam shell granules, the lower the iron (Fe) content in groundwater. The highest percentage of reduction in iron (Fe) content was in 0.8 mm shell granules with a reduction percentage of 89%. Based on the research results, the ability of hemp shells to reduce Fe levels was very good, from a Fe level of 3.656 mg/liter after being filtered with blood clam media it decreased to a level of 0.132 mg/liter. Almost seeding the gold standard (ferrolite) which can reduce up to 0.033 mg/liter. Meanwhile, green mussels can reduce up to 2.64 mg/l. Conclusion: the ability of blood clam shells to reduce Fe levels is very good, able to reduce 96.39% (effective), almost seeding the gold standard (Ferolite) which can reduce up to 99.10%. Meanwhile, green mussels were only able to reduce up to 27.79% (not effective).

Keywords: Clam shells, adsorbent, Fe

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INTRODUCTION

Fishermen of Surabaya's Kenjeran Beach in Bulak District are confused. Shell waste has piled up, but they don't know where to dispose of the waste. Every week there are at least 3 tons of shell shells produced from fishing activities in Bulak District and only 10 percent can be used as handicraft products. So far, residents have used garbage to mix building materials by destroying it first. The rest that cannot be used is thrown into the sea. Garbage from green clam shells in Cilincing has piled up at several points. The height of the waste is up to 5 meters, there is a strong smell, now the waste is being dumped into the sea.[1–3]

So far, clam and crab shells have only been used for handicrafts such as wall hangings, or for animal feed mixtures. Shellfish shell waste contains high calcium carbonate, which is 98%, which has the potential to be utilized. Based on the results of previous studies on clam shell powder, the results were quite good at absorbing heavy metals. This research exploits the potential of shellfish in another form, namely shell ash as an alternative adsorbent that is environmentally friendly, because shell ash consists of compounds namely 7.88% SiO2, 1.25% Al2O3, 0.03% Fe2O3, 66.70% CaO, and 22.28% MgO. Based on the chemical composition, the CaO content in the shell ash is quite high so that the shell ash has the potential as an adsorbent.[4,5]

Water is a basic need for living things, both in terms of quality, quantity and continuity. Based on Permenkes Number 32 of 2017 concerning Environmental Health Quality Standards and Water Health Requirements for Sanitary Hygiene Purposes, Swimming Pools, PerAqua Solutions, and Public Baths for chemical examination, one of which is iron (Fe) permissible levels <1 mg/L. High levels of iron (Fe) in water can be bad for health, which

accumulates through skin and digestive tract absorption causing chronic effects on the body such as hemochromatosis.

Groundwater can be polluted physically or chemically. Physically water can be seen from the color, smell, taste. While chemically it can occur such as iron (Fe), manganese, calcium, chlorine, and others. One of them is chemical pollution in water caused by metal iron, caused by human activities or geographical location which used to be swamps and rice fields. To reduce the level of iron (Fe) in water can be done by means of adsorption. Water treatment by adsorption is an effective method to overcome the problem of environmental pollution. The adsorption method depends on the ability of the adsorbent surface to attract gas, vapor or liquid molecules.[6–8]

If the iron dissolved in water exceeds the threshold it will cause several disturbances, namely 1) technical disturbances in the form of Fe deposits that are corrosive to iron pipes and will settle in pipelines, resulting in blockages and other negative adverse effects. 2) Physical disturbances caused by the presence of iron in water that exceeds 10 mg/L will make the water colored, smell like rotten eggs and cause an unpleasant taste. 3) Health problems that can be caused due to iron compounds in small amounts in the human body function as a formation of red blood cells, where the body requires 7-35 mg/day, some of which is obtained from water. However, Fe substances that exceed the dose needed by the body can cause health problems. In large doses, Fe can damage the intestinal wall, causing irritation to the eyes and skin.[9–11]

METHODS AND MATERIALS

This type of research is quasi-experimental in nature, which is a research method that uses a quantitative approach, carrying out three control activities, manipulating activities, and observation. In this study the researchers treated water containing Fe using blood clam shells and green mussel shells, as adsorbents/media.The research was conducted at the Workshop of the Department of Environmental Health, Jakarta II Health Polytechnic. This research was conducted in May - September 2022. The sample is part of the selected population, namely well water made so that the Fe content is > 2 ppm.

RESULTS AND DISCUSSION

In this study, a trial was carried out for the most effective adsorbance diameter in adsorbing Fe, then with an appropriate diameter a trial was carried out for a comparison of the effectiveness of green mussel shell waste, hemp shells and compared with ferrolite as the gold standard.

Table 1: Results of the Percentage of Decreased Fe Levels Trial

No	Sizeof Green Clam Shell Granules (Pernaviridis)	Iron (Fe) content before treatment (mg/L)	Average levels of Iron (Fe) after treatment (mg/L)	Difference in the average decrease in iron levels (mg/L)	Percentage of decrease in iron content (%)
1	Control	2,95	2,62	0,33	89
2	0,8 mm		0,86	2,09	29
3	1,5 mm		1,09	1,86	37
4	2,5 mm		1,13	1,82	38
5	3 mm		1,13	1,82	38

Based on these results it can be seen that there is a decrease in iron (Fe) content by using variations in the size of clam shell granules as an adsorbent. The smaller the size of the clam shell granules, the lower the iron (Fe) content in groundwater. The highest percentage of reduction in iron (Fe) content was in 0.8 mm shell granules with a reduction percentage of 89%. This is because the smaller the diameter, the wider the cross-section that binds Fe in 1 mg of shellfish compared to granules with larger diameters.

Table 2: Results of Trial of Reducing Iron Levels

No	Adsorbent type	Replication 1 (mg/L)	Replication 2 (mg/L)	Replication 3 (mg/L)	Average (mg/L)
1	Raw Water	3,624	3,659	3,685	3,656
2	Control	3,418	3,476	3,394	3,429
3	Ferrolite	0,038	0,026	0,035	0,033
4	Virgin Clam	0,088	0,118	0,191	0,132
5	Green Shells	2,894	2,065	0,962	2,640

Based on the research results, the ability of hemp shells to reduce Fe levels was very good, from a Fe content of 3.656 mg/liter after being filtered by hemp shell adsorption it decreased to a level of 0.132 mg/liter. Almost seeding the gold standard (ferrolite) which can reduce up to 0.033 mg/liter. Meanwhile, green mussels can reduce up to 2.64 mg/l. The most dominant component in clam shells is calcium carbonate (CaCO3) around 96%, so that it can be used as an adsorbent and able to bind Fe in water. In order to prove that the media is the best in reducing Fe in water, the effectiveness calculation is carried out as follows

Table 3: Adsorbance effectiveness of green, clams and ferrolite

No	Adsorbance/media type	Average Fe levels before treatment (mg/l)	The average Fe content after treatment	Percentage of Decrease (%)	Effectiveness
1	Control	3,656	3,429	6,21	Not effective
2	Ferrolite	3,656	0,033	99,10	Effective
3	Virgin Clam	3,656	0,132	96,39	Effective
4	Green Shells	3,656	2,640	27,79	Not effective

Based on the results of the research, the ability of hemp shells to reduce Fe levels was very good, capable of reducing 96.39% (effective), almost seeding the gold standard (Ferolite) which was able to reduce up to 99.10%. Meanwhile, green mussels were only able to reduce up to 27.79% (not effective). The results of the effectiveness test proved that the hemp was able to reduce the Fe content in water up to 96.36. Iron compounds in small amounts in the human body function to form red blood cells, but excess Fe can cause health problems such as poisoning where vomiting occurs, intestinal damage, premature aging to sudden death, arthritis, birth defects, bleeding gums, cardiomypathies, renal failure, constipation. For households, high iron levels can cause the floor of the house and the walls of the tub to turn red if exposed to this water continuously. In addition, clothes will be red / yellow when used for washing. Iron and manganese will precipitate in pipes, pressure tanks, water heaters and softeners. This will reduce the discharge and water pressure. The accumulation of iron and manganese will become an economic problem if pipes and equipment have to be replaced. Energy will be even more wasteful, because extra energy is needed to pump through a pipe that is shrinking due to iron deposition. By filtering using blood clam media, water with a high iron content which is harmful to health can be avoided. This is evidenced by statistical tests as follows:

Table 4: statistical test with the Anova test

Jenis media	Mean	SD	95% CI	p-value
Raw Water	3.656	0.0177	3.579 – 3.732	0,0001
Control	3.429	0.0422	3.325 – 3.534	
Ferrolite	0.033	0.0062	0.017 – 0,048	
Virgin Clam	0.132	0.0529	0.0007 – 0.264	
Green Shells	2.650	0.4821	3.848 – 2,095	

From the results of statistical tests, it was found that there was a significant difference in the results of iron content after treatment between raw water, control, ferrolite, hemp and green mussels with a P value of 0.0001, which means that there was a significant difference in the average decrease in iron content in different media. . In further testing with the post hock test, it was found that there was a significant difference between the media of hemp and green mussels and the control, but there was no difference between hemp and Ferolite media. This shows that there is no significant difference in the level of iron in the water after treatment between ferrolite and hemp, which means that the ability of blood clams to reduce Fe levels is the same as that of ferrolite as the gold standard. Blood clam media is very good to use as a filter media to reduce iron levels in water so that iron in water will not interfere with health for the body.

CONCLUSION

Based on the results of the study, it can be concluded that the ability of blood clams to reduce iron levels in water is the same as that of ferrolite as a standard guild.

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