Evaluating Coconut Shell and Rice Husk Charcoal for Heavy Metal Adsorption in Green Mussels form Jakarta Bay

Kusrini Wulandari[1], Sri Ani[2], Ai Emalia Sukmawati[3], Bina Rachma Permatasari[4]

[1, 2, 4]Ministry of Health, Health Polytechnic Jakarta II, Environmental Health Department
Hang Jebat III Road, South Jakarta 12120, Indonesia
[1] Email: *wulan.lppsdm[at]gmail.com*
[2]Email: *sri_ani22[at]yahoo.com*
[4]Email: *bina[at]poltekkesjkt2.ac.id*

[3] Ministry of Health, Health Polytechnic Jakarta II, Food and Pharmaceutical Departement
Ragunan Highway 29c, Sunday Market 12520, Indonesia
Email: *ai.emalia14[at]gmail.com*

Abstract: ***In Jakarta Bay, green mussels are significant for their nutritional value but face contamination from heavy metals. Despite their nutritional value, these mussels are frequently the cause of food poisoning due to the significant concentrations of heavy metals such as mercury (Hg), cadmium (Cd), lead (Pb), chromium (Cr), and tin (Sn). This study evaluates the effectiveness of coconut shell and rice husk charcoal as adsorbents for mercury and cadmium in green mussels, this study intends to determine the active charcoal content from variations of coconut shell charcoal and rice husk. Over the course of two years, this study was carried out in two stages. Results from Phase I showed that rice husk was less effective at absorbing mercury from green mussels the higher its composition percentage. The efficacy of cadmium levels in water treated with activated charcoal made from rice husks and coconut shells shown that both materials had good adsorption capacities, according to the research's Phase II results. Based on the stability test using the gravimetric analysis method, sample A has the lowest water and ash content compared to the other four samples. . The results demonstrate the high adsorption capabilities of both materials, with specific variations in performance. This research underlines the potential of using agricultural waste for environmental health applications.***

Keywords: Heavy metal adsorption, environmental health, agricultural waste, green mussels, activated charcoal.

1. Introduction

One of the marine resources from the Bivalvia group that has potential as a food source for the community in Indonesia is green mussels. (Perna viridis) (Syah et al., 2019). The green mussel, or Perna viridis, is a highly valuable bivalve. Mussels are popular in the community and have a high nutritional value. If compared to other marine biota, clams are more resistant to water conditions contaminated with heavy metals and bacteria from industrial and household waste. This is what causes its abundance. Besides containing protein and fat, green mussels also contain vitamins (A and B12) and minerals. (phosphorus, potassium, calcium, and iron). Clam output value rises by 3220,92 tons annually, according to the Directorate General of Capture Fisheries (2015) in (Mahardhika et al., 2016). Because of their enormous population in Indonesian waters, green mussels (Perna viridis) have a lot of potential for use, according to research by Eshmat et al., (2014).

Green mussels are filter feeder organisms that are easier to absorb metals so that the metals can stay longer in the mussels. Green mussels are filter feeders, meaning that mussels filter water to get their food. This is in consistent Eshmat et al., (2014) which states that species that are filter feeders will more easily accumulate heavy metals. Organisms that are filter feeders also have low mobility so that they easily accumulate heavy metals in their bodies (Ernaningsih et al., 2023).

Heavy metal pollution is a serious environmental problem, and can have detrimental effects on human health and ecosystems. Heavy metals such as cadmium (Cd) and mercury (Hg) are very dangerous because they are toxic, accumulative, and can accumulate in the food chain, which especially threatens aquatic organisms and consumers who rely on these resources, including humans. Jakarta Bay, as one of the densely populated aquatic ecosystems, experiences significant pollution due to industrial activities, domestic waste, and inadequate waste processing. According to Arifin et al., (2021), heavy metals are regarded as contaminants in water bodies if their concentration surpasses the quality guideline limitations. The disposal of industrial waste, which includes both organic and inorganic wastes in the form of solids or liquids including heavy metals like cadmium (Cd), is growing along with Indonesia's industry. Green mussels are beginning to contain high levels of heavy metals as a result of the current water conditions.

Nearly all heavy metals, including significant concentrations of mercury (Hg), cadmium (Cd), lead (Pb), chromium (Cr), and tin (Sn), are present in green mussels from Jakarta Bay, making them hazardous and perhaps poisonous. The digestive tract may sustain damage as a result of acute mercury poisoning. Cell membrane damage and denaturation of inactive enzyme proteins were noted in laboratory tests (Sudarmaji et al., 2006). Activated charcoal can be used during the boiling process in an attempt to lower the amount of heavy metals. The high levels of heavy metals in the bodies of green mussels are due to their filter feeder nature, making it easy for heavy metals to accumulate in their bodies during their growth phase (Anggo, 2017). According to the National Standardization Agency in 2009, the safe limits for heavy metal in food is 1 mg/kg for Cd, Pb, and Hg (Solang et al., 2019).

Activated charcoal is charcoal that has undergone activation, resulting in physical changes. Activated charcoal is a good adsorbent because it has many pores. There are several materials that can be made into activated charcoal to remove heavy metals from wastewater through the adsorption process, such as rice husks, animal bones, wood, bamboo, sugarcane bagasse, coal, coffee bean husks, and peanut shells. Adsorption is the process of gas or liquid binding to a solid surface, forming a thin layer on the solid surface called an adsorbent or absorber.

Coconut shell charcoal and rice husk charcoal are two types of materials commonly used in the heavy metal adsorption process. Both have unique characteristics that can contribute to binding heavy metals through the adsorption process. Coconut shell charcoal is rich in activated carbon and has large micropores, making it effective in absorbing hazardous substances in water. Meanwhile, rice husk charcoal, which is made from agricultural waste, has the same potential in improving water quality at a lower cost and abundant availability. By processing these two types of charcoal into adsorbent materials, it is expected to significantly reduce the levels of heavy metals cadmium and mercury in green mussels.

According to earlier studies, coconut shell charcoal has a greater carbon content, which makes it a possible source of heavy metal-absorbing activated carbon. Coconut shells can therefore be utilized as absorbers of heavy metals (Budi et al., 2012). Rice husks are also used to make activated charcoal, in addition to coconut shells. Activated charcoal and rice husk can be utilized as planting media. Heavy metals can be absorbed by using rice husk activated charcoal. According to the study's findings, rice husk charcoal can lower mercury levels by up to 100% and coconut shell charcoal can lower cadmium levels by up to 65.3%. At the moment, the community solely employs charcoal to lower the amount of heavy metals. Based on this condition, this research aims to determine the effectiveness of adsorption of heavy metal Cadmium (Cd) and Mercury (Hg) levels in green mussels from Jakarta Bay using coconut shell charcoal and rice husk charcoal in 2024.

The specific objectives of this research are to compare various variations of activated charcoal with contact time, obtain a stable and effective formula as a heavy metal adsorbent on green mussels, obtain effective activated charcoal tablets as a heavy metal adsorbent in Jakarta Bay, and empower the community in the utilization of activated charcoal tablets to reduce heavy metal content in green mussels.

2. Materials and Methods

This work employs an experimental methodology by determining the efficacy of using coconut shell charcoal and rice husk charcoal as absorbents to reduce the levels of the heavy metals cadmium (Cd) and mercury (Hg) in green mussels from Jakarta Bay in 2024. The Environmental Health lab and Muara Angke Village in North Jakarta are the study sites. March 2024 to November 2024 is the research period. One green mussel from Jakarta's northern coast serves as the study's population, and the sample was drawn from the green mussels in Muara Angke Village, North Jakarta.

The procedure carried out includes the production of coconut shell charcoal, followed by the production of rice husk charcoal, then activation and the creation of active charcoal concentrations using 5 variations:

Table 1: Variation in activated carbon concentration

	A	B	C	D	E
Coconut shell charcoal	100%		75%	50%	25%
Rice husk charcoal		100%	25%	50%	75%

The stages of making charcoal from coconut shells are first preparing the materials used. The material used is old brown coconut shells. Before being dried, the coconut shells are washed thoroughly and cleaned of any remaining fibers. The cleaned coconut shells are then dehydrated or dried under sunlight for 3 days. After drying, the coconut shells are carbonized or burned in a drum until they turn into charcoal. The carbonized coconut shells are then ground using a mortar and pestle and sifted using a mesh sieve of 20. Then, the sifted coconut shell charcoal undergoes the activation process. The carbonized coconut shell is mixed with 1% NaOH and soaked for 1 x 24 hours. Then, the resulting carbon precipitate is separated by filtering using filter paper and discarding the activation liquid. After undergoing a chemical activation process, the coconut shell charcoal is neutralized by washing it with clean water and then sun-dried.

Meanwhile, the stages in making rice husk charcoal are first, choose a burning location that is far from housing or roads, because the process of burning rice husks will produce thick smoke. It is better to make the base of the burning place made of hard heat-resistant flooring, or cover the bottom with zinc plate before burning. This is to make it easier to take the rice husk charcoal. Then make a campfire the size of the cylinder that we made earlier. The fuel can use newspaper, firewood or dry leaves. Then light the fire, then cover the fire with the cylinder that has been given a chimney. Next, fill the combustion chamber of the cylinder which already has a flame with several sacks of rice husks. The pile is piled up to a height of approximately 1 meter with the peak of the pile of chimneys sticking out. After 20-30 minutes or when the peak of the pile of rice husks looks black, raise the husks that are still brown below towards the peak. Continue doing this until all the rice husks are completely black. After all the husks have turned black, pour water over them until evenly distributed. Watering is done to stop the burning process. If the combustion process is not stopped then the husk charcoal will turn to ash. After watering and the temperature has dropped, dismantle the mountain of charcoal husks and dry them. Then put it in a sack and store it in a dry place (Listiana et al., 2021).

Next, each is immersed in green mussel soaking water, where each receives the same treatment with contact times of 30 minutes, 60 minutes, and 90 minutes. After that, each was examined for heavy metal content (Cd and Hg) before and after the intervention. Finally, calculate the effectiveness of its absorption with AAS examination. The stability test on coconut shell charcoal and rice husk was conducted using the gravimetric analysis method to determine the moisture content and ash content. Data analysis techniques are used to measure effectiveness levels using the Kruskal-Wallis statistical test. The Kruskal-Wallis test is a non-parametric statistical test that can be used to test whether there is a significant difference between groups of independent variables and their dependent variables (Rozi et al., 2022). Then to measure the content of activated carbon using the Activation method. Activation functions to increase the size of the pores that have formed during the carbonization process and to form new pores (Muhajir et al., 2021). Last, to measure heavy metal content using the LC-PMS method with AAS.

Activated charcoal from coconut shell and rice husk were then characterized to determine the water content and ash content of both activated charcoals. The water content was determined by taking 1 gram of activated carbon, then drying it in an oven at a temperature of 105ºC. Drying continued until a constant carbon mass was obtained, then the carbon was cooled in a desiccator. The percentage of water content was calculated using the equation below: (Muhajir et al., 2021)

$$\text{Water content (\%)} = \frac{initial\ sample\ weight - final\ sample\ weight}{initial\ sample\ weight} \times 100\%$$

Ash content is done by taking 1 gram of activated carbon, then drying it in an oven (temperature 105ºC) until a constant mass is achieved. The carbon is then heated in a furnace at a temperature of 650ºC for 4 hours. Before being weighed, the carbon is first cooled in a desiccator. The calculation of the total ash percentage is obtained using the equation below, namely: (Muhajir et al., 2021)

$$\text{Ash content (\%)} = \frac{residual\ sample\ weight}{initial\ sample\ weight} \times 100\%$$

3. Results and Discussion

3.1 The Effectiveness of Mercury Levels in Water Before and After Treatment

Mercury can enter water sources through a variety of pathways, including industrial waste, mining, and pesticide use. When mercury dissolves in water, it can form more hazardous organic compounds, such as methylmercury, which can accumulate in the food chain. Therefore, it is important to monitor and control mercury levels in water to protect public health and the environment. Water quality standards set by global health organizations, such as the WHO, set a maximum limit for mercury levels in drinking water of 0.006 mg/L. Levels exceeding this limit can potentially harm human health.

The effectiveness of mercury levels in water was calculated using data from mercury levels before and after treatment with activated charcoal media from coconut shells and rice husks, with variations including A (100% coconut shells), B (100% rice husks), C (75% coconut shells and 25% rice husks mixture), D (50% coconut shells and 50% rice husks mixture), and E (25% coconut shells and 75% rice husks mixture). Here are the results of mercury and cadmium levels before and after treatment using activated charcoal from coconut shell and rice husk media.

Table 2: Laboratory results of activated carbon for Hg and Cd

No.	Code	Sample Type	Parameter being Checked	Test Results
1	A	Charcoal before treatment	Mercury (Hg) Cadmium (Cd)	0,012 mg/L <0,001 mg/Kg
2	B	Charcoal before treatment	Mercury (Hg) Cadmium (Cd)	0,005 mg/L <0,001 mg/Kg
3	C	Charcoal before treatment	Mercury (Hg) Cadmium (Cd)	0,006 mg/L <0,001 mg/Kg
4	D	Charcoal before treatment	Mercury (Hg) Cadmium (Cd)	0,005 mg/L <0,001 mg/Kg
5	E	Charcoal before treatment	Mercury (Hg) Cadmium (Cd)	0,004 mg/L <0,001 mg/Kg

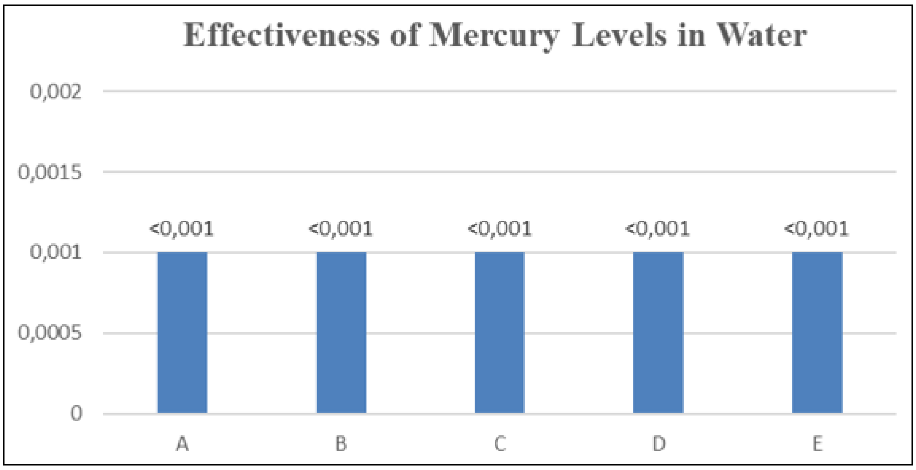

Figure 1: Effectiveness of Mercury Levels in Water Before and After Treatment with Activated Charcoal from Coconut Shells and Rice Husk

The results of the study on the effectiveness of mercury levels in water treated using activated charcoal media from coconut shells and rice husks show that both materials have good adsorption capabilities. From the analysis of five samples, an average mercury concentration of 0.001 mg/L was obtained, with some samples showing lower concentrations, namely

<0.001 mg/L. The results of the Kruskal-Wallis statistical test show that the significance value or p-value obtained is 1.000, which means this value is greater than 0.05. This indicates that there is no significant difference in the mercury levels in the tested water, even when using various media variations, such as coconut shells and rice husks. In other words, despite the use of these media variations for testing, the measured mercury levels in the water remain consistent and do not show significant variation.

Both coconut shell activated charcoal and rice husk have a porous structure that allows interaction with mercury ions. However, the adsorption capacity of the two media can differ depending on the physical and chemical properties of the media. Coconut shell activated charcoal, with a larger surface area, showed better absorption than rice husk. However, rice husk still has significant potential as an adsorption medium. The consistency of mercury levels measured after treatment using both media indicates that the adsorption process is effective. This confirms that both media can be an environmentally friendly alternative in the treatment of mercury-contaminated water. In addition to being affordable, these materials are also agricultural waste products that can be reused, thus supporting the principle of sustainability. However, there are several factors that can affect the effectiveness of adsorption, such as pH, temperature, the amount of media used and contact time. Lower pH can increase the adsorption capacity of mercury, because in acidic conditions, mercury tends to be in the form of ions that are easier to adsorb. In addition, longer contact time between contaminated water and activated charcoal can also increase the effectiveness of mercury removal.

The mechanism of mercury adsorption on activated charcoal involves physical and chemical interactions between the charcoal surface and mercury ions. Activated charcoal has very small pores, which allow mercury molecules to be trapped inside. In addition, the presence of functional groups on the surface of activated charcoal can contribute to chemical interactions with mercury ions, increasing adsorption efficiency. This process not only reduces mercury levels in water, but can also help remove other contaminants that may be present.

3.2 The Effectiveness of Cadmium Levels in Water Before and After Treatment

Cadmium (Cd) is a heavy metal that is harmful to human health and the environment. Cadmium levels in water can come from various sources, including industrial waste, agriculture, and other human activities. Cadmium exposure can cause various health problems, including kidney damage, osteoporosis, and cancer. Cadmium levels in water are often measured to determine the level of pollution. In many areas, cadmium levels that exceed safe limits can be found, especially near industrial sites. High levels of cadmium in water can result in accumulation in aquatic organisms, which can then enter the food chain and impact human health. Therefore, the treatment of cadmium-contaminated water is very important to maintain environmental quality and public health.

The effectiveness of cadmium levels in water was calculated using data from the reduction of cadmium levels before and after treatment with activated charcoal from coconut shells and rice husks, with variations including A (100% coconut shells), B (100% rice husks), C (75% coconut shells and 25% rice husks), D (50% coconut shells and 50% rice husks), and E (25% coconut shells and 75% rice husks).

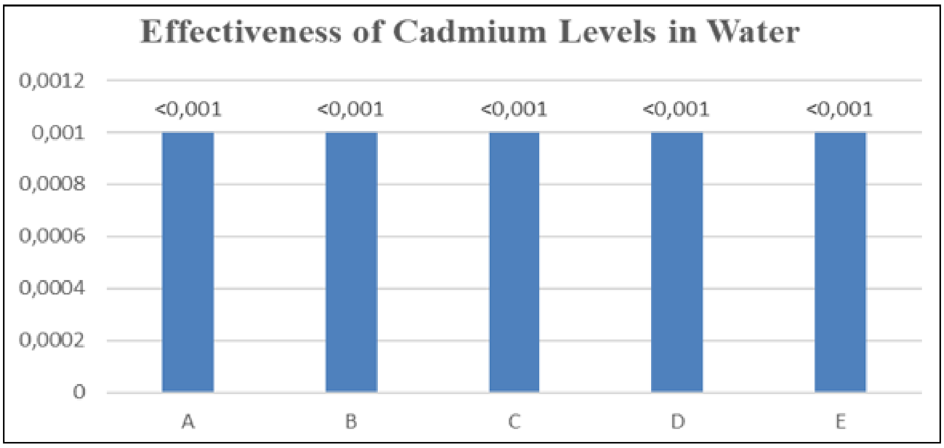

Figure 2: Effectiveness of Cadmium Levels in Water Before and After Treatment with Coconut Shell Activated Charcoal and Rice Husk

The results of the research on the effectiveness of cadmium levels in water treated with activated charcoal media from coconut shells and rice husks show that both materials have good adsorption capabilities. From the analysis of five samples, an average cadmium concentration of 0.001 mg/L was obtained, with some other samples showing lower concentrations, namely <0.001 mg/L. The results of the Kruskal-Wallis statistical test indicate that, with a p-value or significance value of 1.000, there is no significant difference in the cadmium levels in the tested water despite using various media variations, such as rice husks and coconut shells. This shows that the cadmium levels remain consistent and are not affected by the media variations.

Cadmium adsorption by activated charcoal can be explained through physical and chemical adsorption mechanisms. Physical adsorption occurs through weak bonds such as Van der Waals forces, while chemical adsorption involves stronger bonds, such as ionic and covalent bonds between cadmium and the surface of the activated charcoal media. The

Paper ID: SR241202091755 DOI: https://dx.doi.org/10.21275/SR241202091755

difference in adsorption capacity between coconut shell and rice husk may be due to the differences in chemical composition and pore structure of the charcoal produced from these two materials.

This research also showed that despite variations in the physical and chemical characteristics of the activated charcoal media, the cadmium levels in the water remained consistent after the adsorption process. This indicates that both media are effective in capturing cadmium ions, and there is no substantial change in cadmium levels due to the specifications of the media used. This is an important finding, because the practice of water treatment using various types of activated charcoal media can be widely applied, depending on the availability of materials and local needs.

3.3 Effectiveness of Mercury Levels in Green Mussels Before and After Treatment

Mercury is a dangerous heavy metal that can cause a variety of health problems, including nervous system damage and developmental disorders. Mussels can accumulate mercury from the seawater and sediments in which they live. Reducing mercury levels in mussels is not only important for human health, but also for maintaining the balance of marine ecosystems. Mussels are an important part of the food chain in marine ecosystems, and the accumulation of mercury in their bodies can impact predators higher in the food chain, including humans. Mercury levels in mussels vary depending on the location of collection, the level of environmental pollution, and other factors.

The effectiveness of mercury levels in clams by comparing mercury level data before and after treatment using active charcoal media derived from coconut shells and rice husks, with treatment variations including Control (clams without active charcoal media treatment), A (100% coconut shell), B (100% rice husk), C (75% coconut shell and 25% rice husk mixture), D (50% coconut shell and 50% rice husk mixture), and E (25% coconut shell and 75% rice husk mixture).

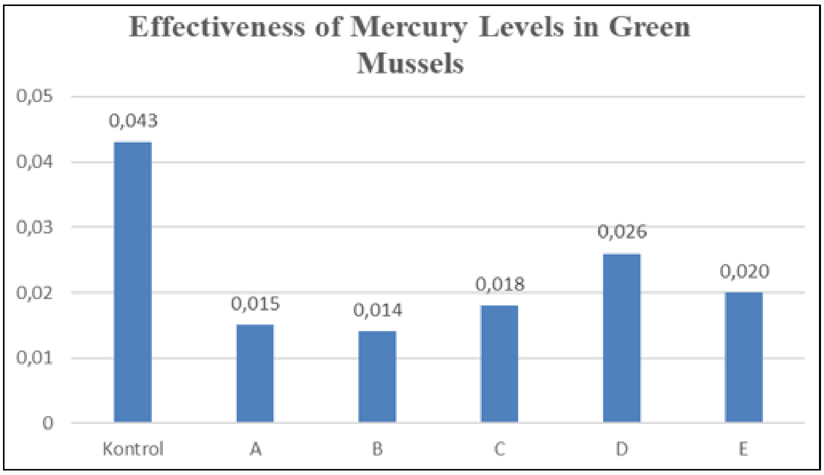

Figure 3: Effectiveness of Mercury Levels in Green Mussels Before and After Treatment with Activated Charcoal from Coconut Shells and Rice Husk

The research results show that the mercury content in green mussels without treatment with activated charcoal media reached the highest value of 0.043 mg/L. This indicates that the green mussels store mercury in significant concentrations without any treatment that can reduce these levels. On the other hand, when the clams were treated with an activated charcoal medium consisting of a mixture of 75% coconut shell and 25% rice husk (with sample code C), the measured mercury content became lower, at 0.014 mg/L. This indicates that the use of an activated charcoal medium from coconut shell and rice husk is effective in reducing the mercury content in clams. This study indicates the potential of activated charcoal media as a method to reduce mercury levels, which has important implications for environmental health and food safety.

The results of the study using the Kruskal-Wallis statistical test provide information regarding the significance value or p-value obtained, which is 0.676. This value is greater than the commonly used threshold, which is 0.05. This means that, based on statistical criteria, there is no significant difference in the mercury levels detected in the tested clams. Although various media, such as coconut shells and rice husks, were used in the treatment, the test results showed that the mercury levels remained consistent and did not show significant variation. This indicates that the treatment methods applied do not have a significant effect in reducing the mercury content in green mussels.

The mechanism behind the effectiveness of activated charcoal media in reducing mercury levels in green mussels can be explained through several processes. Activated charcoal has a large surface area and high adsorption capacity, so it can attract and bind mercury molecules that accumulate in the mussel's body. This process occurs through physical and chemical interactions between the surface of activated charcoal and mercury ions, which allows for a reduction in mercury concentration in mussel tissue. In addition, the use of a mixture of coconut shells and rice husks as activated charcoal media also shows good potential. Coconut shells are rich in carbon and have a porous structure that supports the adsorption process, while rice husks can improve the physical and chemical properties of the activated charcoal. This combination is not only effective in reducing mercury levels, but is also environmentally friendly, because it utilizes agricultural waste that is often unused.

3.4 Effectiveness of Cadmium Levels in Green Mussels Before and After Treatment

Cadmium (Cd) is a heavy metal that can be found in a variety of sources, including water, sediment, and aquatic organisms. Cadmium levels in mussels can be affected by a variety of factors, including water quality, human activities, and environmental conditions. Cadmium can enter the body of mussels through a bioaccumulation process, where mussels absorb heavy metals from the water and food they consume. This process is greatly influenced by the concentration of cadmium in the surrounding environment. In several studies, cadmium levels in mussels taken from contaminated sites showed significant numbers, indicating that mussels can be effective accumulators of this heavy metal. This is a serious concern, especially for communities that rely on mussels as a food source, because consuming contaminated mussels can cause long-term health effects.

The effectiveness of cadmium content in shells is determined by comparing the cadmium content data of coconut shells and rice husks before and after treatment with activated carbon media. The treatment variations in this study included six groups: Control (clams without active charcoal media treatment), A (100% using coconut shells), B (100% using rice husks), C (75% coconut shells and 25% rice husks), D (50% coconut shells and 50% rice husks), and E (25% coconut shells and 75% rice husks).

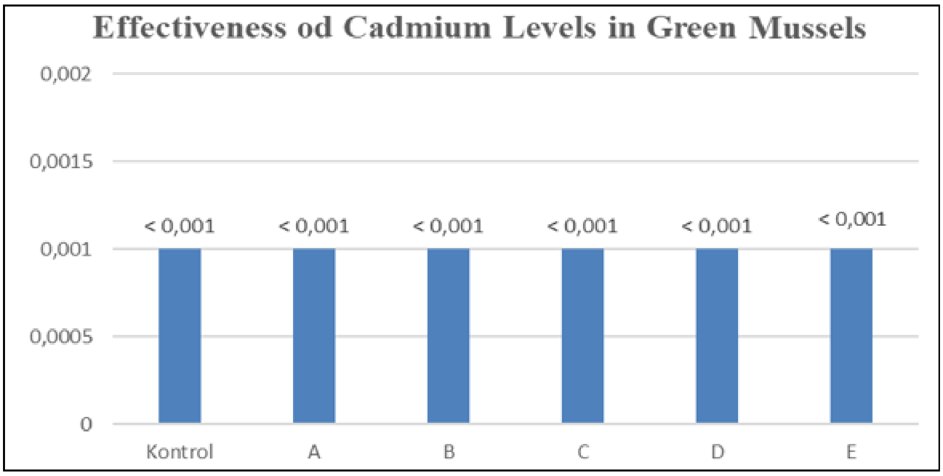

Figure 4: Effectiveness of Cadmium Levels in Green Mussels Before and After Treatment with Activated Charcoal from Coconut Shells and Rice Husk

The results of the study on the effectiveness of cadmium levels in green mussels show that green mussels that did not receive treatment with activated charcoal media have very low cadmium levels, with a measurable value of <0.001. This indicates that even without treatment, green mussels still show minimal cadmium levels. This is likely due to environmental factors and biological adaptation. One of the environmental factors that can affect cadmium levels is water quality and sedimentation in the natural habitat of green mussels. Good water quality, with low concentrations of heavy metals, will support the survival and health of mussels, so they can avoid cadmium absorption. On the other hand, green mussels treated with activated charcoal media derived from coconut shells and rice husks also showed similar results. From the analysis of five different samples, the average cadmium content obtained was also recorded as <0.001. This indicates that even with treatment using activated charcoal media, the measured cadmium levels remain low. Both conditions show high effectiveness in controlling cadmium levels, so whether treated or untreated, the clams still have very low cadmium levels. The use of activated charcoal as a control medium for cadmium levels provides further evidence of the ability of activated charcoal to absorb and bind heavy metals from the surrounding environment. Activated charcoal made from coconut shells and rice husks has high adsorption properties, so it can significantly reduce the concentration of cadmium in water.

Comparison between untreated green mussels and green mussels treated with activated charcoal showed that this method was effective in maintaining low cadmium levels. Although both groups showed very low cadmium levels, activated charcoal treatment showed a better ability to stabilize heavy metal levels in mussels. The ability of activated charcoal to absorb cadmium can provide benefits in pollution control, as this substance can be used as a remediation tool in ecosystems affected by industrial or agricultural waste. Cadmium absorption by green mussels not only depends on the treatment, but is also influenced by external factors such as water quality, environmental conditions, and the presence of pollution sources. In some locations with lower levels of pollution, green mussels tend to have lower levels of cadmium. Therefore, good environmental management and monitoring of water quality are very important to maintain the population of green mussels and minimize the risk of heavy metal pollution.

The results of the analysis using the Kruskal-Wallis statistical test show that the obtained p-value is 1.000, which indicates that this value is far greater than the established significance threshold of 0.05. In the context of this research, this means that there is no significant difference in the measured cadmium levels in green mussels, even though the testing was conducted using various media variations, such as coconut shells and rice husks. The Kruskal-Wallis test is often used to analyze data that is not normally distributed and can test differences between two or more independent groups. With a p-value of 1.000, the researchers can conclude that the media treatment factor does not have a different effect on the cadmium levels in green mussels. This indicates that although

Paper ID: SR241202091755 DOI: https://dx.doi.org/10.21275/SR241202091755

media variations were applied, neither coconut husk nor rice husk had a significant impact on the absorption of cadmium in the tested green mussels.

3.5 The Effectiveness of Mercury Content on Charcoal Before and After Treatment

Charcoal produced from different raw material sources can have varying levels of mercury. Improper charcoal-making processes or the use of contaminated raw materials can increase the levels of mercury in the final product. For example, charcoal produced from wood grown in areas exposed to industrial or agricultural waste that uses mercury-based pesticides can contain high levels of mercury. Studies using coconut shell and rice husk charcoal, which are common raw materials, can also be affected by these factors. Coconut shell and rice husk charcoal have good potential to adsorb various contaminants, including mercury. Coconut shell and rice husk charcoal are two types of charcoal that are commonly used in various applications, including as fuel and adsorbent media in water purification processes. Both have different physical and chemical characteristics, which can affect their effectiveness in adsorbing contaminants, including mercury. Coconut shell charcoal, for example, is known to have high porosity and large surface area, making it effective in adsorbing various hazardous substances.

The effectiveness of mercury content in coconut shell and rice husk charcoal before and after treatment can be analyzed through several approaches. Before treatment, mercury levels in charcoal can be measured using chemical analysis techniques such as spectroscopy or chromatography. The results of this measurement provide an initial picture of the potential hazards that may be caused by the charcoal if used in certain applications, such as in water purification or as fuel. After treatment, such as chemical or physical activation, mercury levels in charcoal can change. Activation aims to increase the surface area and porosity of charcoal, which in turn can increase its ability to adsorb mercury.

The effectiveness of mercury content in charcoal is determined by comparing the mercury content data of coconut shells and rice husks before and after treatment with activated carbon media. The treatment variations applied in this study included: Control (charcoal without active charcoal media treatment), A (100% coconut shell), B (100% rice husk), C (75% coconut shell and 25% rice husk mixture), D (50% coconut shell and 50% rice husk mixture), and E (25% coconut shell and 75% rice husk mixture).

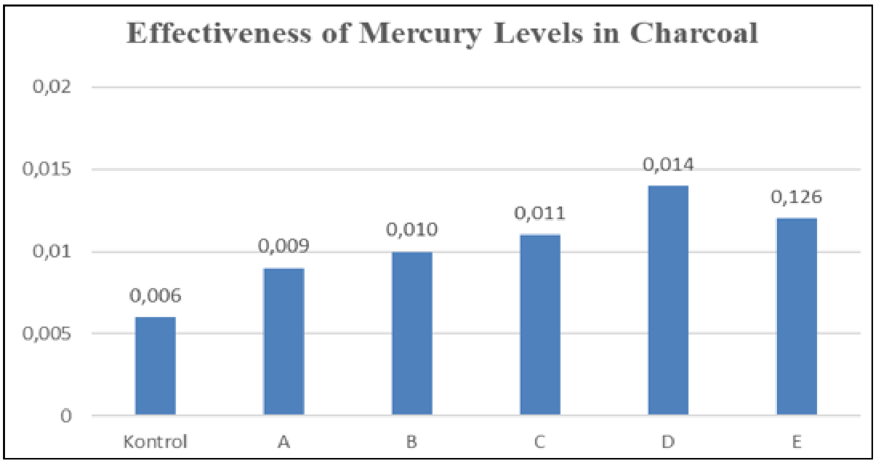

Figure 5: The Effectiveness of Mercury Levels in Charcoal Before and After Treatment with Activated Charcoal Media from Coconut Shells and Rice Husk

The research results show that the mercury content in untreated charcoal without activated charcoal media was recorded at 0.006 mg/L, while the highest mercury content in charcoal treated with a mixture of 50% coconut shell and 50% rice husk activated charcoal media (sample code D) was 0.014 mg/L. This indicates that although this treatment increases the charcoal's ability to absorb mercury, the measured mercury content is still higher compared to untreated charcoal, thus providing insights into the effectiveness of various media in mercury content processing. Although mixed media charcoal showed increased mercury levels compared to untreated charcoal, this indicates the need for a more holistic approach to reducing environmental pollution. For example, other media combinations and alternative treatment methods should be further explored to create more effective solutions.

In further analysis, it is important to understand how the media used works and the mechanism of interaction between mercury and charcoal. Activated charcoal is known to have a large surface area and large pores, allowing the absorption of various contaminants through physical and chemical processes. Meanwhile, the mixture of rice husks aims to facilitate the structure of activated charcoal, but in this condition, it does not seem to have the expected effect. One factor that may cause higher mercury levels in processed charcoal is the chemical reaction that occurs during the processing process. The heating and processing processes can affect the physical and chemical properties of charcoal, causing a decrease in its adsorption capacity. Furthermore, the mercury levels recorded in processed charcoal can be influenced by various factors, including particle size, porosity, pH, and environmental conditions during processing. If the particle size of the charcoal is too fine or too coarse, this can affect the surface area available for absorption. In addition, if the pH conditions are not optimal, the mercury adsorption process can also be disrupted.

The results of the Kruskal-Wallis statistical test show that the significance value, measured in the form of a p-value, is 0.932. This value is greater than the 0.05 threshold typically used in research to determine statistical significance. Thus, these findings indicate that there is no significant difference in the measured mercury content in the tested charcoal, regardless of the media used, such as coconut shells and rice husks. This implies that despite the use of various media in the testing process, the effect is not strong enough to produce variations that can be considered significant in the mercury content found in the charcoal. Consequently, the researchers can conclude that the media variations applied in this experiment do not affect the mercury content in the charcoal samples studied.

3.6 Effectiveness of Cadmium Levels on Charcoal Before and After Treatment

Cadmium levels in charcoal, especially charcoal produced from coconut shells and rice husks, are of significant interest in environmental and health research. Charcoal produced from these two materials has the potential as an adsorbent to reduce heavy metal levels, including cadmium, in various applications, such as wastewater treatment and contaminated soil remediation. Cadmium levels in charcoal can vary depending on the raw material source and charcoal production method. Coconut shell charcoal and rice husk charcoal are two types of charcoal commonly used in research due to their abundant availability and low production costs. Coconut shell charcoal has good adsorption capacity for heavy metals, including cadmium, due to its highly porous structure and large surface area. In contrast, rice husk also shows significant potential as an adsorbent, although the cadmium content in rice husk charcoal tends to be lower than that in coconut shell charcoal.

The effectiveness of cadmium content in charcoal was analyzed by comparing the cadmium content data before and after treatment with activated carbon media from coconut husk and rice husk. The treatment variations applied in this study included: Control (charcoal without active charcoal media treatment), A (100% coconut shell), B (100% rice husk), C (75% coconut shell and 25% rice husk mixture), D (50% coconut shell and 50% rice husk mixture), and E (25% coconut shell and 75% rice husk mixture).

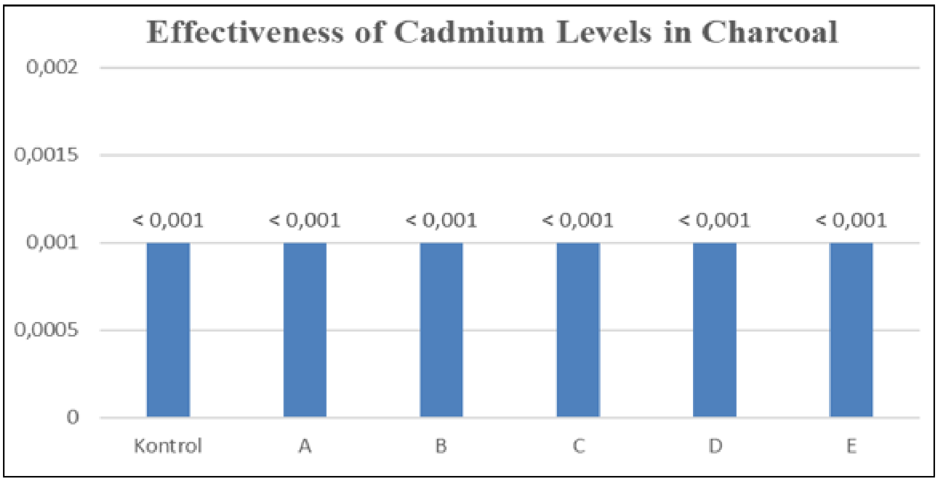

Figure 6: Effectiveness of Cadmium Levels in Charcoal Before and After Treatment with Activated Charcoal Media from Coconut Shells and Rice Husk

According to the research findings, the cadmium content of charcoal treated with active charcoal media made from a mixture of coconut shell and rice husk is also recorded as being very low, with a value of <0.001, indicating that even without processing, the charcoal remains safe from cadmium contamination. This confirms that both untreated charcoal and charcoal treated with active charcoal media have minimal cadmium concentrations, indicating that neither is at high risk of cadmium contamination. Therefore, it is important to take this into account when using the charcoal in relation to health and safety.

Activated charcoal, which is actually often used in filtration and purification applications, can be produced from various raw material sources, including coconut shells and rice husks. Proper processing of these materials can produce activated charcoal with good adsorbent characteristics and low content of harmful substances. In this case, these results confirm that the processing process not only optimizes the physical and chemical properties of charcoal, but also contributes to the reduction of heavy metal contamination, especially cadmium.

These results also confirm that both unprocessed charcoal and charcoal processed with activated charcoal media show minimal cadmium concentrations. This finding is important from two perspectives; first, from a safety perspective, and second, from an application perspective. The very low cadmium content indicates that the coconut shell and rice husk charcoal processing industry has the potential to develop without significant risks to public health. In addition, this safe product shows positive potential for further applications, both in agriculture, industry, and health. From an environmental perspective, the low cadmium content in the charcoal discussed here also indicates that the process of selecting raw materials—coconut shell and rice husk—can be a sustainable alternative. Coconut shell and rice husk are abundant agricultural wastes, so utilizing these materials into charcoal not only helps reduce waste but also supports the principles of a circular economy, where resources are used and managed efficiently.

The results of the Kruskal-Wallis statistical test showed a significance value or p-value of 1.000, which is greater than 0.05, indicating that there is no significant difference in the cadmium content in the tested charcoal, even when using various media variations such as coconut shells and rice husks. Therefore, this study confirms that the cadmium content in charcoal remains stable regardless of the treatment variations applied.

3.7 Stability Test of the Gravimetric Analysis Method

Water Content

Water content is one of the important factors that affect the physical and mechanical properties of materials, including activated carbon. Water content is the amount of water vapor or humidity contained in a material. The presence of water in carbon is related to its hygroscopic properties, which means that activated carbon has a high affinity for water. Because of these properties, activated carbon can be used as an adsorbent. The following are the results of the water content calculations, namely:

Table 3: Water Content

Week	A	B	C	D	E
0	5,12	5,78	6,33	7,25	7,42
1	5,18	5,85	6,21	7,31	7,53
2	5,22	5,87	6,28	7,32	7,56
3	5,23	5,92	6,35	7,38	7,55
4	5,20	5,90	6,34	7,37	7,58
6	5,24	5,93	6,38	7,35	7,61
8	5,23	5,95	6,42	7,40	7,66
12	5,24	5,99	6,41	7,39	7,69

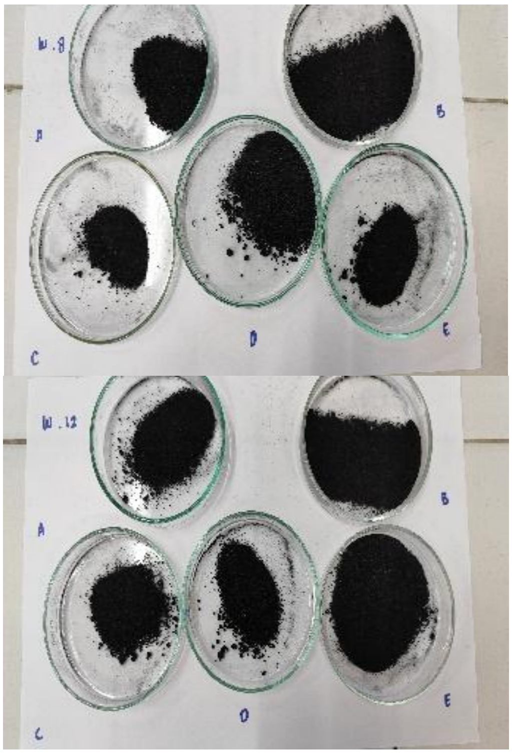

Figure 7: Water Content

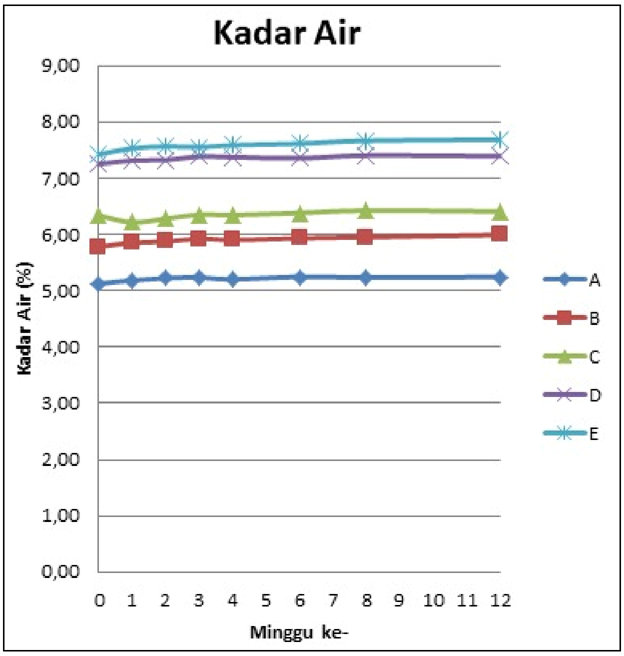

Figure 8: Water Content

Based on the results of the table above, sample A has a lower water content than other samples, this affects the hardness and durability of the sample. So sample A is better in terms of water content. In the case of activated charcoal, high water content can reduce adsorption efficiency, as water can compete with the substances to be adsorbed. Conversely, activated charcoal with low water content shows better potential in the adsorption process, as there is more space available for target molecules to adhere to the charcoal surface. The drying or reduction of water content is usually carried out to enhance the performance of activated charcoal, making low water content an indicator of good quality.

When the water content in sample A is lower, this has a positive effect on the hardness of the activated charcoal itself. Hardness is a measure of a material's ability to resist permanent deformation when stressed. In many industrial applications, high hardness is often desired. In the case of activated charcoal, good hardness can contribute to the physical durability of the charcoal when used in extreme conditions, such as in filters that must withstand a constant flow of water or gas. Thus, low water content will make the microporosity structure of activated charcoal more stable, maintain its physical strength and allow charcoal to function more effectively in various environments.

Apart from that, the durability of sample A is closely related to the minimal water content. Durability here refers to the ability of activated charcoal not to be easily damaged or degraded, even under extreme conditions of use. When moisture content is low, activated charcoal becomes more resistant to dissolution and abrasion, which often occurs when particles interact with other materials in a filtration or adsorption system. Therefore, the better durability of sample A increases the lifetime of activated charcoal and can reduce replacement costs in industrial applications.

On the other hand, if we consider other samples that have higher moisture content, they will most likely show lower hardness compared to sample A. Moisture in such samples can cause erosion of the charcoal particles in the process of use, as well as reduce the efficiency in adsorption. Moisture can also cause the formation of microbial colonies that damage the structure of the charcoal, further reducing its physical durability. Here, we can see that the presence of water content in activated charcoal not only affects the adsorption performance, but also has direct implications for the durability and stability of the material.

Water content is also a determining factor in the activated charcoal production process. The optimal activated charcoal manufacturing procedure should involve drying the raw material to a minimum moisture content before the activation process. This aims to ensure that the internal structure of activated charcoal can be formed properly, as well as to minimize post-manufacturing damage. When the moisture content is at the right level, the activation process can take place more efficiently, producing high-quality activated charcoal that not only stands out in hardness but also durability.

Apart from that, water content also affects the physical and chemical interactions between activated charcoal and the substances around it. In many applications, such as in water or gas processing, the presence of high water content in activated charcoal can create a situation where undesirable chemical reactions occur, which can ultimately damage the quality of the charcoal. With low water content, these reactions can be minimized, increasing the purity of the final product produced.

Ash Content

Ash content is one of the important parameters used to assess the quality of activated carbon. The percentage of ash content identifies the content of metal oxides that may still be present in activated carbon. These metal oxides can be silicon, sulfur, calcium, or other metals in small amounts. High ash content affects the quality of activated carbon when applied as an adsorbent (Jamilatun & Setyawan, 2014). The following are the results of the water content calculations, namely:

Table 4: Ash Content

Week	A	B	C	D	E
0	4,35	4,42	4,33	4,53	4,56
1	4,33	4,45	4,55	4,62	4,57
2	4,35	4,38	4,57	4,57	4,60
3	4,36	4,51	4,49	4,53	4,61
4	4,36	4,41	4,52	4,63	4,58
6	4,37	4,39	4,48	4,59	4,61
8	4,37	4,43	4,44	4,60	4,65
12	4,37	4,49	4,49	4,55	4,63

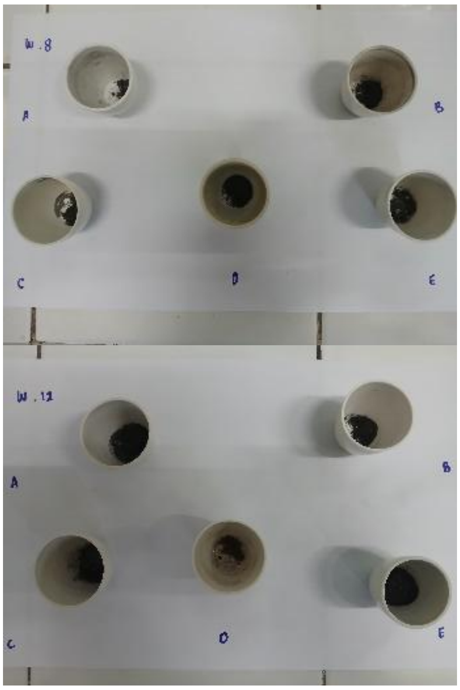

Figure 9: Ash Content

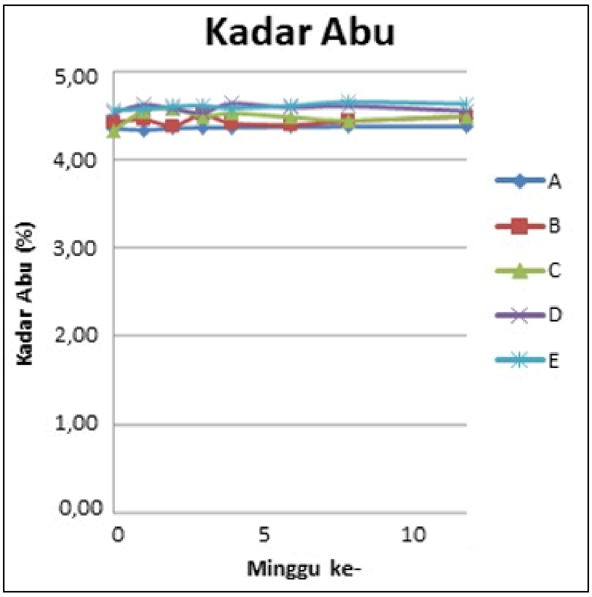

Figure 10: Ash Content

Based on the results of the table above, sample A also has the lowest ash content, which means less metal contamination. Ash content is the amount of residue left after a material is burned at high temperatures. Ash is an inorganic component consisting of minerals and other elements. In the context of sample A made from 100% coconut shell, its lower ash content may indicate that coconut shell, as an organic material, has a lower proportion of elements compared to other materials that might contain more inorganic minerals.

Coconut husk, which is part of the coconut fruit, mainly consists of fibers and easily decomposable organic compounds. When burned, the organic part will evaporate, and if the resulting ash residue is small, it reflects that the material does not contain much inorganic matter. Conversely, if a material contains a lot of heavy metals, including cadmium (Cd) and mercury (Hg), the burning process will produce a higher ash content, because these metals do not evaporate and will remain as residue.

4. Conclusion and Suggestion

The effectiveness of cadmium levels in water treated with activated charcoal media from coconut shells and rice husks shows that both materials have good adsorption capabilities. The use of activated charcoal media from coconut shells and rice husks is effective in reducing mercury levels in green mussels. Based on the stability test using the gravimetric analysis method, sample A has the lowest water and ash content compared to the other four samples. This research indicates the potential of activated charcoal media as a method to lower mercury levels, which has important implications for environmental health and food safety. This study suggests a scalable application of agricultural waste for mitigating environmental pollution and improving food safety standards.

References

[1] Anggo, S. (2017). ANALISIS FISIKA KIMIA DARI KERANG DARA (Anadara granosa) YANG BERASAL DARI KAYUTANYO KAB. BANGGAI. *Jurnal Pendidikan Glasser*, *1*(2), 69–77.

[2] Arifin, A. A., Suryono, C. A., & Setyati, W. A. (2021). Amankah Mengkonsumsi Kerang Hijau Perna viridis L nnaeus, 1758 (Bivalvia: Mytilidae) yang ditangkap di Perairan Morosari Demak? *Journal of Marine Research*, *10*(3), 377–386. https://doi.org/10.14710/jmr.v10i3.31650

[3] Budi, E., Nasbey, H., Budi, S., Handoko, E., Suharmanto, P., & Sinansari, R. (2012). KAJIAN PEMBENTUKAN KARBON AKTIF BERBAHAN ARANG TEMPURUNG KELAPA. *Seminar Nasional Fisika 2012*, 62–66.

[4] Ernaningsih, D., Patanda, M., Rahmani, U., & Telussa, R. F. (2023). Heavy Metal Content in Green Mussels (Perna viridis) Cultivated in Ketapang Village, Tangerang Regency. *Journal of Tropical Fisheries Management*, *7*(1), 35–45. https://doi.org/10.29244/jppt.v7i1.45094

[5] Eshmat, M. E., Mahasri, G., & Rahardja, B. S. (2014). ANALISIS KANDUNGAN LOGAM BERAT TIMBAL (Pb) DAN CADMIUM (Cd) PADA KERANG HIJAU (Perna viridis L.) DI PERAIRAN NGEMBOH KABUPATEN GRESIK JAWA TIMUR. *Jurnal Ilmiah Perikanan Dan Kelautan*, *6*(1), 101–108.

[6] Jamilatun, S., & Setyawan, M. (2014). Pembuatan Arang Aktif dari Tempurung Kelapa dan Aplikasinya untuk Penjernihan Asap Cair. *Spektrum Industri*, *12*(1), 73–86. https://doi.org/10.12928/si.v12i1.1651

[7] Listiana, I., Bursan, R., Widyastuti, R., Rahmat, A., & Jimad, H. (2021). Pemanfaatan Limbah Sekam Padi Dalam Pembuatan Arang Sekam di Pekon Bulurejo, Kecamatan Gadingrejo, Kabupaten Pringsewu. *Intervensi Komunitas: Jurnal Pengabdian Masyarakat*, *3*(1), 1–5. https://doi.org/10.32546/ik.v3i1.1118

[8] Mahardhika, R., Riyadi, P. H., & Fahmi, A. S. (2016). PENGARUH LAMA WAKTU PERENDAMAN KERANG HIJAU (Perna viridis) MENGGUNAKAN BUAH TOMAT (Lycoperdicum esculentum) TERHADAP PENURUNAN KADAR LOGAM TIMBAL (Pb). *J. Peng. & Biotek*, *5*(4), 43–50.

[9] Muhajir, A., Machdar, I., & Mariana, M. (2021). Produksi karbon aktif arang tempurung kelapa menggunakan kombinasi metode aktivasi secara kimia dan steam tekanan rendah. *Jurnal Litbang Industri*, *11*(2), 110–116. https://doi.org/10.24960/jli.v11i2.7104.110-116

[10] Rozi, F., Irma, & Maulidiya, D. (2022). Analisis Perubahan Inflasi Beberapa Kota Besar di Indonesia dengan Menggunakan Uji Kruskal-Wallis. *Multi Proximity: Jurnal Statistika Universitas Jambi*, *1*(2), 103–115. https://online-journal.unja.ac.id/multiproximityhttps://doi.org/10.22437/multiproximity.v1i2.21418

[11] Solang, M., Baderan, D. W. K., & Kumaji, S. S. (2019). Pemberdayaan Masyarakat Dalam Penangananbalita Stuntingmelalui Pemanfatan Pangan Lokalsumber Protein Dan Zink Berbasis Kerangdan Kelordi Kabupaten Pohuwato Provinsi Gorontalo. *Jurnal Pengabdian Kepada Masyarakat*, *25*(2), 85–90. https://jurnal.umj.ac.id/index.php/JPMT/article/view/9804%0Ahttps://www.kemkes.go.id/download.php?file=download/pusdatin/buletin/Buletin-Stunting-2018.pdf

[12] Sudarmaji, Mukono, J., & Corie, I. P. (2006). Toksikologi Logam Berat B3 Dan Dampaknya Terhadap Kesehatan. *Jurnal Kesehatan Lingkungan*, *2*(23), 129–142. https://www.neliti.com/publications/3956/toksikologi-logam-berat-b3-dan-dampaknya-terhadap-kesehatan

[13] Syah, M., Putri, R. M. S., & Pratama, G. (2019). Karakteristik Vitamin dan Mineral Berunok (Paracaudina australis) dari Pantai Pelawan dan Tanjung Melolo Kabupaten Karimun Kepulauan Riau. *Marinade*, *2*(1), 39–52.