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Research Article

Optimization of Temperature and Heating Duration of Giant African Snail (Achatina Fulica) Shells as Natural Adsorbents to Improve the Water Quality of The Kahayan River

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ABSTRACT
This research aims to test the potential of heated snail shells to be used as a natural adsorbent in overcoming water quality problems in the Kahayan River. In this research, snail shells will go through several heating treatments to find the most effective temperature and heating duration for improving water quality. Heating snail shells is expected to increase their ability to adsorb ammonia, reduce turbidity, and increase water pH. The results of this research were that the pH increased significantly after mixing Kahayan River water with snail shells. Heating the snail shell did not have a significant effect on the increase in pH. An increase in temperature can increase the loss of ammonia in the form of gas or NH3 so that its solubility in water will decrease. In the TDS concentration, there was an increase with the heating of the snail shell, but there was a decrease in the increase in TDS due to changes in the concentration of the substances contained therein.

Keywords: Kahayan River water, Snail Shell, pH, Ammonia, TDS

INTRODUCTION

Water quality has become a critical issue in many regions around the world, including Indonesia. The Kahayan River, one of the major natural resources in Central Kalimantan, faces significant challenges in maintaining its water quality. Factors such as pollution from domestic, industrial, and agricultural waste, as well as the degradation of natural ecosystems, often lead to water contamination by various harmful substances, including ammonia and turbidity. Contaminated water poses a threat to human health and aquatic ecosystems, necessitating effective solutions to address these issues (Bustomi, 2020).

Ammonia is one of the common pollutants found in contaminated water, especially in rivers receiving waste from domestic and industrial activities. Ammonia can deteriorate water quality by reducing dissolved oxygen levels, negatively affecting aquatic life. Additionally, high water turbidity diminishes water quality by obstructing sunlight penetration and hindering photosynthesis, which is essential for aquatic organisms. Therefore, water treatment to reduce ammonia and turbidity is crucial for maintaining ecosystem balance and human health (Kwami et al., 2019).

Furthermore, the presence of the Giant African Snail (Achatina Fulica) as a pest is also a problem for the surrounding community. These snails can reproduce rapidly, damage crops, and cause economic losses for farmers. However, many people are unaware of the potential of snail shells to be utilized for other purposes, such as in water treatment. Abundant snail shells can serve as natural materials to adsorb various substances, including ammonia, in water. Utilizing snail shells as natural adsorbents offers an effective solution while simultaneously reducing the number of pests in the environment (Suquet et al., 2021).

This study aims to examine the potential of heated snail shells as natural adsorbents to address water quality issues in the Kahayan River. In this research, snail shells will undergo several heat treatments to determine the most effective temperature and duration for improving water quality. Heating the snail shells is expected to enhance their ability to adsorb ammonia, reduce turbidity, and increase water pH (Mahdavi et al., 2017).

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The significance of this research lies in combining two aspects: utilizing abundant materials as a solution for water pollution problems and promoting eco-friendly water treatment. By using snail shells as natural adsorbents, it is hoped to find a water treatment method that is more affordable, accessible, and environmentally friendly. This study aims to contribute positively to water quality management in the Kahayan River and mitigate existing pollution impacts (Etemadi et al., 2021).
Therefore, this research seeks to evaluate the effectiveness of heating snail shells in improving water quality by analyzing parameters such as pH, turbidity, and ammonia levels. By utilizing snail shells as natural adsorbent materials, this study is expected to provide a more environmentally friendly and accessible solution for addressing water quality issues in the Kahayan River.

METHODOLOGY

This study began with the collection of abundant snail shells from areas surrounding the Kahayan River. The snail shells were cleaned to remove any attached impurities and then ground into a fine powder with a mesh size of 100 to increase their surface area. The ground shells were subsequently dried at 60°C for 3 hours to reduce their moisture content before undergoing heat treatment. The treated snail shells were then divided into four treatment groups to be tested under different heating conditions: no heating (0 hours at 300°C), heating for 1 hour at 300°C, heating for 2 hours at 300°C, and heating for 3 hours at 300°C. After the heat treatments, the samples were tested using the jar test method with 250 mL of water from the Kahayan River. The parameters analyzed in this study included pH, turbidity, and ammonia levels to evaluate the effectiveness of snail shells in water treatment.

RESULTS & DISCUSSION

A significant increase in pH was observed after mixing the Kahayan River water with snail shells (Putro & Santoso, 2022; Santoso & Putro, 2020). However, the heat treatment of the snail shells did not significantly affect the observed pH increase (Ouafi et al., 2024). In principle, an increase in temperature inversely correlates with pH elevation. This occurs because higher temperatures accelerate the dissociation of water into hydrogen ions (H^+) and hydroxide ions (OH^-). The increase in hydrogen ions subsequently lowers the pH. Therefore, the higher the temperature of the snail shells mixed with the Kahayan River water, the lower the resulting pH (Närhi et al., 2022).

Table 1 Results of pH Level Testing

Treatment	Initial pH	Post-Treatment pH	Increase (%)
Heating for 0 Hours	5.84	8.02	37.33
Heating for 1 Hours	5.84	8.00	36.99
Heating for 2 Hours	5.84	7.70	31.85
Heating for 3 Hours	5.84	7.45	27.57

The presence of carbon dioxide (CO_2) in the Kahayan River water can influence the pH. Higher temperatures increase the solubility of carbon dioxide, which can react to form carbonic acid (H_2CO_3) (Yang et al., 2022). Additionally, temperature has the potential to affect microbial activity and other chemical reactions in the water, which can produce either acids or bases. At higher temperatures, microorganisms generate organic acids or decompose organic matter more rapidly, which tends to inhibit the increase in pH of the Kahayan River water caused by the addition of snail shells (Ovuoraye et al., 2022; Senthilkumar et al., 2024). Across all four treatments, the pH increase was observed to approach neutral pH, which is approximately 7..

Table 2 Results of Ammonia Level Testing

Treatment	Initial Ammonia (mg/L)	Post-Treatment Ammonia (mg/L)	Increas (%)
Heating for 0 Hours	0.8	0.4	50
Heating for 1 Hours	0.8	0	100
Heating for 2 Hours	0.8	0	100
Heating for 3 Hours	0.8	0	100

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Ammonia in the Kahayan River water has negative impacts on human health, such as digestive tract disorders, respiratory issues, and skin irritation. Therefore, it is essential to reduce the concentration of ammonia in the Kahayan River water (Brito et al., 2025; Guillen-Burrieza et al., 2023). Naturally, ammonia can dissipate in the Kahayan River water. An increase in temperature can enhance the loss of ammonia in the form of gas (NH_3), thereby reducing its solubility in water (Eljamal et al., 2022; Kumar et al., 2021; Li et al., 2022). This phenomenon was observed in the study results following the heat treatment of snail shells. The heat treatment proved to be highly effective in reducing ammonia levels. With 1-hour heating, ammonia levels decreased by 50%, and a 100% reduction was achieved with 2 and 3 hours of heating.

Table 3 Results of TDS (Total Dissolved Solids) Testing

Treatment	Initial TDS (mg/L)	Post-Treatment TDS (mg/L)	Increas (%)
Heating for 0 Hours	16	121	656,25
Heating for 1 Hours	16	121	656,25
Heating for 2 Hours	16	74	362,50
Heating for 3 Hours	16	68	325,00

The concentration of Total Dissolved Solids (TDS) can affect human health. High TDS levels can cause health issues such as skin irritation, digestive disorders, and heavy metal poisoning, whereas low TDS levels can lead to deficiencies in essential minerals, disrupt the body's electrolyte balance, and alter the taste of water (McCleskey et al., 2023; Rangseesuriyachai et al., 2024). High temperatures can increase the solubility of dissolved solids; however, they may also affect TDS measurements due to changes in the water's electrical conductivity (Forhad et al., 2024). Therefore, TDS measurements should consider temperature to obtain more accurate results. As temperatures rise, water tends to dissolve more solids (such as salts, minerals, and other compounds) (Songpayome et al., 2024). This can cause an increase in TDS levels, even though the total amount of dissolved solids remains constant, as these compounds are more soluble at higher temperatures. Additionally, if water evaporates at high temperatures, TDS levels will increase because the volume of water decreases while the amount of dissolved solids remains unchanged (Devesa & Dietrich, 2018; Patra, dos Santos Ribeiro, Yirga, Puchala, et al., 2024). This results in a higher concentration of dissolved solids, potentially leading to increased TDS readings.

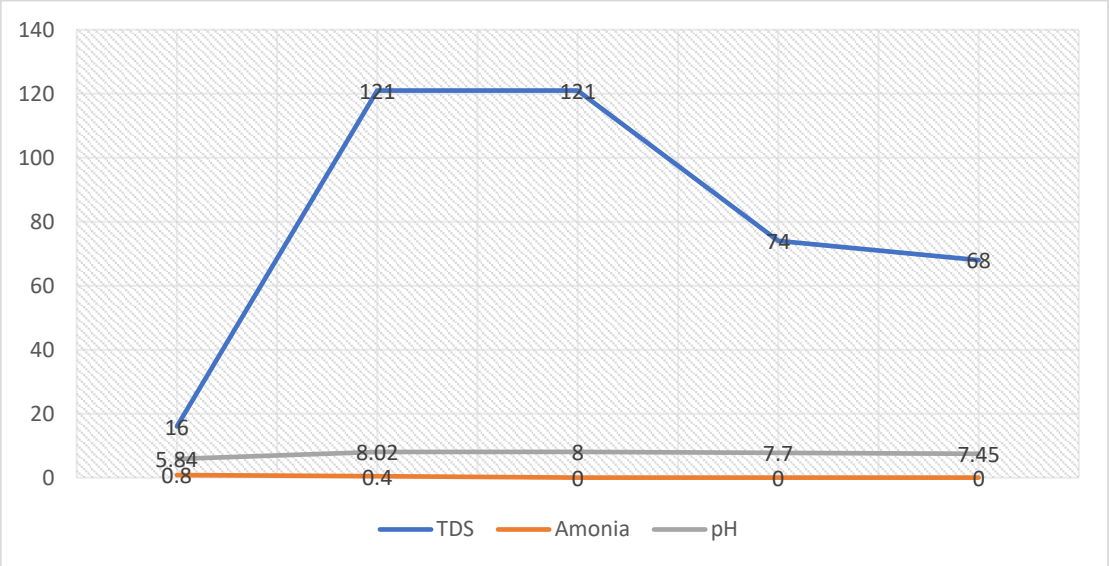

Figure 1 Graph of pH Levels, Ammonia, and TDS Results

The research results showed an increase in TDS concentration across all treatments. The differences observed were in the magnitude of the TDS concentration increase. Higher heating temperatures of the snail shells tended to result in lower increases in TDS concentration. This is because prolonged heating of the snail shells affects the concentration of substances contained within them (Patra, dos Santos Ribeiro, Yirga, Sonibare, et al., 2024).

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CONCLUSION

The conclusions drawn from this study are as follows: A significant increase in pH was observed after mixing the Kahayan River water with snail shells. Heat treatment of the snail shells did not have a significant impact on the observed pH increase. Higher temperatures enhanced the loss of ammonia in the form of gas (NH_3), thereby reducing its solubility in water. For TDS concentration, an increase was observed with the heat treatment of snail shells; however, a subsequent reduction in the TDS increase occurred due to changes in the concentration of substances contained within the shells.

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