Jurnal Presipitasi
Media Komunikasi dan Pengembangan Teknik Lingkungan
e-ISSN: 2550-0023

Vol 21, No 3, 2024, 869-878
Article available at [homepage presipitasi]

Regional Case Study

Domestic Wastewater Treatment to Control River Pollution in Sungai Pinang, Samarinda, East Kalimantan

Eko Suhartono[1], Erlena[2], Hapsari Lintang Sekartaji[3], Gusti Muhammad Perdana Putera[4], Iskandar Thalib[5], Isna Syauqiah[6], Ifa Hafifah[7], Ha Thi Thu Trang[8]**

[1]Department of Medical Chemistry and Biochemistry, Faculty of Medicine, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia 70714
[2]Department of Environmental Health, Faculty of Public Health, Universitas Mulawarman, Samarinda, East Kalimantan, Indonesia 75119
[3]Student of Public Health, Master's Program, Faculty of Medicine and Health Sciences, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia 70714
[4]Faculty of Dentistry, Universitas Lambung Mangkurat, Banjarmasin, South Kalimantan, Indonesia 70232
[5]Public Health Study Program, Undergraduate Program, Faculty of Medicine and Health Sciences, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia 70714
[6]Department of Chemical Engineering, Faculty of Engineering, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia 70714
[7]Nursing Study Program, Faculty of Medicine and Health Sciences, Universitas Lambung Mangkurat, Banjarbaru, South Kalimantan, Indonesia 70714
[8]Nursing Program, School of Medicine and Pharmacy, Vietnam National University
* Corresponding Author, email: esuhartono@ulm.ac.id

CC BY SA

Abstract

Filtration is a method for controlling water pollution. This study aimed to engineer a filtration system using a combination of *Melaleuca cajuputi* (galam) wood charcoal and zeolite to process domestic wastewater. The research focused on domestic wastewater from Sungai Pinang Village, Samarinda, East Kalimantan, an area with significant water pollution issues. The samples were divided into three groups, each containing zeolite and galam wood charcoal in different ratios: Group 1 (1:1), Group 2 (1:2), and Group 3 (2:1). Each sample was exposed to contact times of 30, 60, and 90 minutes. Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammonia (NH_3), and pH were measured for each treatment group at each contact time. Results showed that prolonged contact with the filtration method significantly reduced all parameters except pH ($P<0.05$). Each treatment combination did not significantly reduce all parameters except pH ($P>0.05$). Group 2 was found to be the most effective in improving water quality. In conclusion, this study demonstrates that the filtration method can reduce pollutant levels, with the combination of galam wood charcoal and zeolite in a 2:1 ratio being the most effective.

Keywords: Domestic wastewater; filtration; treatment engineering; water pollution

1. Introduction

Environmental pollution is a critical global issue resulting from factors such as industrialization, population growth, urbanization, uncontrolled fuel use, and increased motorized traffic (Awewomom et al., 2024; Manisalidis et al., 2020). This problem has detrimental effects on the environment, including disruptions to ecosystems and harm to living organisms, including humans (Manisalidis et al., 2020). Water pollution is one of a global concern that requires international cooperation and special attention.

Many countries are implementing measures to enhance water waste management to tackle this issue (Warren-Vega et al., 2023).

Liquid waste is categorized into domestic, industrial, and atmospheric liquid waste (Abduraimov, 2021). Domestic wastewater originates from household activities such as bathroom use, washing, and other household chores (Bakkara and Purnomo, 2022; Widyarani et al., 2022). Domestic wastewater can be classified into four types: yellow (urine), brown (feces plus toilet flush water), black (urine, feces, and bacterial activity), and gray (liquid waste from kitchen, laundry, bathroom, and handwashing facilities) (Koul et al., 2022). Domestic wastewater significantly contributes to water pollution in many developing countries with high population densities, like Indonesia. This conclusion is supported by data on water pollution in major rivers across Indonesia. For example, data from Jakarta indicates that domestic liquid waste makes up about 70% of water pollution in the city, while the industrial and manufacturing sectors contribute around 15% and 14%, respectively (Harahap et al., 2020).

Samarinda is one of the cities in Indonesia and serves as the capital of East Kalimantan province. The majority of the city is situated in the flow areas of two major rivers, the Mahakam and Karang Mumus rivers. The Sungai Pinang District in Samarinda City is densely populated and serves as a hub for economic, social, administrative, and environmental services (Mariani et al., 2021). This district is also known for its numerous housing complexes, schools, and home industries, including businesses that produce crackers and engage in hand-painting (Asti and Mayasari, 2023). The activities of the residents in this area contribute to the increase in domestic wastewater resulting from community activities (Mariani et al., 2021). Domestic wastewater typically contains detergents, shampoos, soaps, bleaches with chlorine, nitrogen, and phosphorus compounds (Hayat, 2020; Maliga et al., 2022). Moreover, domestic wastewater includes oil and organic food waste that can decompose, leading to the formation of NH_3 in water bodies. NH_3 levels exceeding 1 ppm can be detrimental to fish, causing their death in water bodies (Satria et al., 2019). Indiscriminate disposal of wastewater can cause water bodies to become murky and unpleasant smelling. This situation can lead to eutrophication due to high levels of Nitrogen (N) and Phosphorus (P), resulting in excessive weed growth that can cover water bodies (Akinnawo, 2023). When eutrophication occurs, sunlight is blocked, halting photosynthesis and causing oxygen levels to drop. This lack of oxygen can lead to the death of aquatic organisms and decrease the levels of BOD and COD (Shivsharan and Wani, 2017).

Domestic wastewater derived from organic matter can also be oxidized into weak acids such as oxalic acid, acetic acid, tartaric acid, and others, lowering the pH of the water (Magowo et al., 2020). This change in pH can cause fish and aquatic organisms to perish due to acidic conditions (Darmawan et al., 2021). Moreover, this acidic environment fosters the growth of bacteria and viruses that thrive in such conditions. If this contaminated water is used for bathing, it poses a risk of skin irritation and itching (Yehia and Said, 2021).

To mitigate water pollution, particularly in the Sungai Pinang area, various policies have been put in place. One of the key policies is education and awareness campaigns aimed at increasing public knowledge and changing behaviors related to domestic wastewater disposal. Previous studies have shown that wastewater treatment management is also effective in overcoming and reducing water pollution. For successful implementation of wastewater management methods in society, they must be designed with ease of manufacturing and low production costs at scale (Utari and Herdiansyah, 2020). Wastewater treatment methods have been developed using three primary approaches: physical, chemical, and biological methods. One of the most practical and cost-effective methods is physical filtration (Tarru et al., 2021; Utari and Herdiansyah, 2020).

Filtration uses the principle of separating solid materials from liquids using porous media. Filtration has been shown to effectively remove colloids, suspended matter, and other impurities from water, thereby minimizing contaminant levels (Hamdan et al., 2022). This method is typically carried out using various materials, such as gravel, activated charcoal, zeolite, and sand. Sand has been found to have the lowest effectiveness among these materials. However, the combination of activated charcoal and zeolite has been shown to be one of the most effective filtration methods for reducing pollutants in domestic wastewater (Utari and Herdiansyah, 2020).

Zeolite is an adsorbent that has been widely researched and is naturally found as crystalline aluminosilicates. Zeolite has been widely used for filtration due to its abundance in nature, making it a low-cost application. In contrast, activated charcoal, which is the oldest and most well-known adsorbent in wastewater treatment, is quite expensive to use and is not as readily available as zeolite (Onyutha et al., 2024). Activated charcoal is an organic material derived from substances with high carbon content, such as coal, coconut shells, or wood dust (Haryati et al., 2017).

Melaleuca cajuputi subsp. cumingiana, also known locally as is a plant that grows in lowland areas, shallow peat forests, and swamp areas. This plant is abundant in several regions of Indonesia, such as South Kalimantan (Ardhana and Alimah, 2018). Galam wood remains a valuable commodity that provides many benefits to people, both personally and economically. However, its utilization is currently limited and not optimal. Galam wood is mainly utilized as a component in building construction. After its use, the wood waste is often discarded and ends up as organic waste (Supriyati et al., 2015; Anggraini and Muzaidi, 2020). Research conducted by Haryati et al. (2017) revealed that galam bark holds potential as a source of active carbon. Additionally, a study by Alpian et al. (2010) indicated that activated charcoal derived from galam wood can enhance the water quality of wells and rivers, leading to improvements in various water quality parameters, with the exception of pH.

The combination of zeolite and activated charcoal from galam wood as a filtration media in domestic wastewater treatment has not been widely studied. Therefore, this present study aims to examine the effect of combining zeolite and activated charcoal from galam wood as a filtration media in domestic wastewater treatment from Sungai Pinang, Samarinda, East Kalimantan. The media is expected to remove colloidal particles and pollutants, resulting in clean and clear water suitable for reuse in irrigation and other purposes. In addition, improvements in water quality parameters such as pH, BOD, COD, and NH_3 levels are expected to be observed, indicating the effectiveness of the filtration media. If the results of this study support further research, then the combination of filtration using zeolite and activated charcoal from galam wood is a new media combination that can be used in the domestic liquid waste treatment.

2. Methods

2.1. Domestic wastewater sampling

This study employed a pre-and post-test design to evaluate the effectiveness of combining zeolite and activated charcoal from galam wood in improving domestic wastewater quality parameters. The study focused on wastewater collected from several drainage areas in the Sungai Pinang District, Samarinda City, East Kalimantan Province, Indonesia (**Figure 1**). Sungai Pinang District is a district resulting from the expansion of Samarinda District, East Kalimantan. The Sungai Pinang area borders North Samarinda District to the north and Samarinda Ilir District to the south, while to the west and east are Samarinda Ulu District and Sambutan District, respectively. The population of Sungai Pinang in 2023 is 861,878 people with an area of 34.16 km².

Daily wastewater samples were collected for 14 days between 7:00-10:00 am, as this period corresponds to the peak hours of community activities such as washing, bathing, and cooking. prevent contamination, the wastewater samples were taken in clean containers and rinsed with distilled water before measurement. Prior before the initial water quality parameters of pH, BOD, COD, and NH_3 were measured.

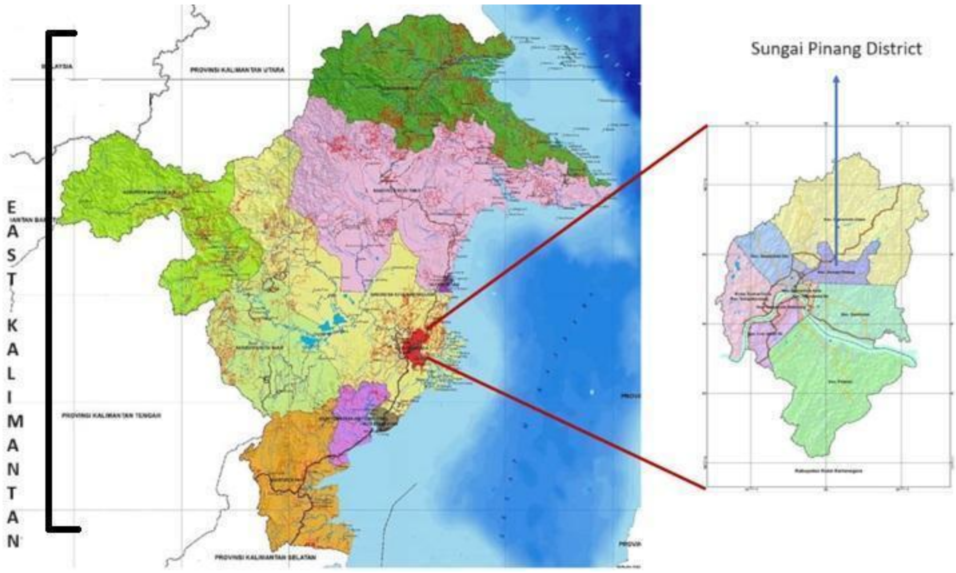

Figure 1. Domestic wastewater sampling location points in Sungai Pinang District

2.2. Wastewater treatment diagram

The wastewater treatment system is set up with three tanks at different heights from the floor (**Figure 2**) using a downflow operation system. Each tank is made of plastic and has the same dimensions: 31 cm in length, 21 cm in width, and 70 cm in height, with a water volume of 2 L. The design of the water tank in this study is based on the tank created by Amri and Wesen (2015) for domestic wastewater treatment.

Wastewater enters the initial first tank with a pipe at the bottom of the tank. Subsequently, the wastewater flows from the initial tank into the second tank, which is the filtration tank. The filtration tank comprises variations of media combinations: (1) 1500 grams of zeolite + 1500 grams of galam wood activated charcoal (1:1); (2) 1000 grams of zeolite + 2000 grams of galam wood activated charcoal (1:2); and (3) 2000 grams of zeolite + 1000 grams of galam wood activated charcoal (2:1). The filtration treatment process lasted for 90 minutes for each treatment. The water samples were collected at 30, 60, and 90 minutes from the outlet pipe at the bottom of the filtration tank. After each filtration treatment, the water quality parameters were measured, including pH, BOD, COD, and ammonia. Additionally, the galam wood charcoal used has a mesh size range of 50-70, and the design of the wastewater treatment with the filtration system is shown in **Figure 2**.

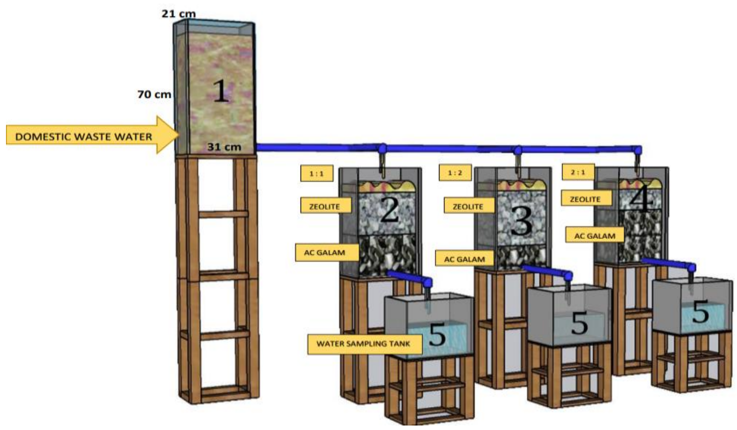

Figure 2. Process diagram illustration for domestic wastewater treatment system. (1) initial tank; (2) treatment 1 group (1:1; zeolite: galam wood activated charcoal); (3) treatment 2 group (2:1; zeolite: galam wood activated charcoal); (4) treatment 3 group (1:2; zeolite: galam wood activated charcoal); and (5) water sample for analysis. AC: Activated Charcoal

2.3. Water quality analysis

Wastewater pH measurements were conducted using an electrometric method with pH meters. Prior to usage, the pH meter was calibrated with three buffer solutions at pH 5, 7, and 9 to ensure precise readings. Following calibration, the electrode was immersed into the wastewater until the pH meter displayed a stable reading (Ramayanti and Amna, 2019).

The BOD level was analyzed using Winkler's titration method. BOD levels were measured by taking a 60-mL wastewater sample. The sample was added to a Winkler bottle and diluted with distilled water until full. Then, one sample was incubated for five days at 20°C as DO5. A second sample was prepared similarly, without incubation. Next, each sample solution received one milliliter of $MnSO_4$ solution and one milliliter of alkali iodide azide solution added with the pipette tip directly above each solution. Each mixture was covered, homogenized until a perfect lump formed, and left for five to ten minutes in the dark by wrapping it in aluminum foil. One milliliter of concentrated H_2SO_4 solution was added to each mixture, and the bottle was closed again and left until the precipitate had become homogeneous and completely dissolved. The resulting solution was transferred to a 50-mL Erlenmeyer flask and titrated using $Na_2S_2O_3$ as an indicator, with starch added as an indicator. Titration continued until the blue color disappeared, and results were recorded (Ramadani et al., 2021).

The COD level is measured using Winkler's or titration method. To begin, 2 ml of wastewater samples and 8 ml of distilled water are combined. Next, 5 ml of the diluted sample is transferred to an Erlenmeyer flask. Then, 5 ml of H_2SO_4 6N solution and 20 ml of $K_2Cr_2O_7$ are added. The mixture is shaken and heated in a water bath for 10 minutes. After heating, the mixture is allowed to cool until it reaches a temperature of 25°C and then wrapped in aluminum foil. The resulting mixture is titrated with 0.1 N $Na_2S_2O_3$ until a yellow color appears. Subsequently, 10 drops of starch are added as an indicator. The titration process continues until the blue color turns light green (Ramadani et al., 2021).

NH_3 levels in water are measured using the spectrophotometric method. This method involves preparing a sample solution by adding 1 ml of 10% phenol solution and sodium nitroprusside to a 25 ml water sample. Standard solutions with concentrations of 0, 0.2, 0.4, 0.6, 0.8, and 1 ppm ammonia were also prepared. Each sample and standard solution was then mixed with 2.5 ml of oxidizing solution, covered with aluminum foil, and left for 1 hour to allow for the reaction. After an hour, the solutions turned blue, and their absorbance was measured using spectrophotometry at a wavelength of 630 nm (Butler et al., 2022).

2.4. Data analysis

This research was conducted by analyzing laboratory data, specifically the results of testing the parameters pH, BOD, COD, and NH_3 in domestic wastewater before and after treatment. Each measurement was repeated three times, and the average was calculated. laboratory data were compared with the required quality standards set by the Minister of Environment and Forestry Regulation Number 68 of 2016, which regulates the environmental regulations for wastewater treatment. Furthermore, Additionally, test data were analyzed using Two Two-Way ANOVA the IBM SPSS statistics for Windows 11 application to determine the effect of treatment combination and contact time in improving the water quality parameters measured in this study. Statistical significance was set at $P < 0.05$ for all tests, tests identify differences. Data were using tables, figures, etc., with the help of Microsoft Excel 2019 for Windows 11.

3. Result and Discussion

Before undergoing treatment with various combinations of wastewater treatment processes at different times, the quality parameters of domestic wastewater were measured as initial parameters. These initial parameters were measured as follows. The parameters were also compared with the standard water quality regulations set forth in Minister of Environment and Forestry Regulation Number 68 of 2016. The initial water quality parameters and their comparison with the standards are presented in Table 1.

Table 1. Initial characteristics of wastewater

Parameter	Unit	Values in Wastewater	Standard Value
pH		5.3	6.0 – 9.0
BOD	mg/L	75.66	30
COD	mg/L	136.97	100
NH_3	mg/L	11.108	10

The results in Table 1 show that the wastewater has been polluted with pollutants. This can be seen from the pH value, BOD, COD, and NH3 levels, which exceed the standard values. High BOD and COD concentrations of wastewater are due to high organic content, resulting in an increased demand for oxygen gas. The higher the BOD and COD concentrations, the fewer microorganisms can survive in them (Nurhayati et al., 2019). On the other hand, the NH_3 in wastewater is also high. NH_3 measured in waters is in the form of total ammonia (NH3 and NH4+). NH_3 is a byproduct of the decomposition of plant or animal proteins or their feces. Artificial fertilizers also contain ammonia and its compounds, so the runoff from fertilizers carried by water can decompose and potentially increase the NH_3 content in the water (Sulistya and Septisya, 2019). According to Hidayah (2018), the high concentrations of BOD, COD, and NH_3 illustrate that organic materials have polluted the environment; therefore, it is necessary to carry out treatment.

In this study, we propose a filtration method using a combination of zeolite and activated galam wood charcoal to enhance water quality parameters. We employed three different combination treatments: 1:1, 1:2, and 2:1 for zeolite to activated galam wood charcoal comparison, respectively. Additionally, we measured water quality parameters at three different intervals: 30, 60, and 90 minutes. The results of measuring water quality parameters at these time points and combinations of treatments are presented in Table 2.

Table 2. Wastewater quality parameters (pH, BOD, COD, and NH_3) in several treatment groups at different times

Treatment Group	Parameter	Unit	Time Contact (minute)			
			30	60	90	P Value
I	pH		5.4	5.5	5.7	
	BOD	mg/L	38.32	36,95	35,38	0,035
	COD	mg/L	90.70	83,20	66,90	0,021
	NH_3	mg/L	9,711	9,644	9,543	0,025
II	pH		5.5	5.6	5.7	
	BOD	mg/L	67,81	36,95	21,65	0,042
	COD	mg/L	124,98	108,47	97,48	0,037
	NH_3	mg/L	9,153	9,118	9,043	0,045
III	pH		5.4	5.6	5.8	
	BOD	mg/L	34,07	31,65	29.47	0,035
	COD	mg/L	98,01	86,40	79,58	0,021
	NH_3	mg/L	9,128	9,068	9,055	0,025

The results presented in Table 2 show that the contact time and treatment combination affect the pH value, BOD, COD, and NH_3 levels. The increase in pH did not seem to have met the standard quality standards set by the Indonesian government. Conversely, the BOD level was lower than the standard quality standards at the 90th minute in the filtration process using a zeolite to activated charcoal ratio of 1:2 and 2:1. In contrast to pH and BOD, the COD value was consistently lower than the standard quality standards in all treatment groups, except for group 2 at 30 and 60 minutes. All treatments at all time periods exhibited ammonia levels below the standard quality standards.

The results presented in Table 2 show that the contact duration with each treatment combination significantly affects the pH value, BOD, COD, and NH3 levels ($p < 0.05$). The data indicate a significant increase in pH and a decrease in BOD, COD, and NH3 levels. The results of this study are consistent with those of Kurniawati and Sanudin (2020), who found that contact time in the filtration method can decrease the level of BOD and COD in batik industry waste. Additionally, Wirosoedarmo et al.'s (2020) research study states that contact time can affect BOD and COD levels in domestic wastewater

The improvement in water quality is attributed to the adsorption of activated charcoal derived from galam wood, which can eliminate aromatic compounds and dissolved compounds (Zilfa et al., 2022; Muzarpar et al., 2020). Adsorption occurs when the attractive forces between solute molecules and the adsorbent are stronger than those between the molecules and the solvent. Additionally, adsorption can take place through weak bonds such as hydrogen bonds and van der Waals forces, enabling molecules to adhere to the surface of the adsorbent. The longer contact duration allows for more pollutants to be removed by activated charcoal from galam wood (Dewi et al., 2018), as more pollutants are captured by the adsorbent over time.

The results in Table 2 also show that the treatment combination did not significantly change the water quality parameters measured in this study ($p > 0.05$). However, the BOD, COD, and NH3 levels showed a decrease, except for pH. The decrease in BOD, COD, and NH3 levels is presumably due to the increase in pH value. The level of acidity greatly affects changes in the surface charge of the adsorbent during the adsorption process. In this process, H+ and OH- will compete to attach to the cavities of the adsorbent. The effectiveness of the composition of zeolite and galam wood activated charcoal in increasing adsorption rates was found to be about 1.89-9.43%. Meanwhile, BOD levels decreased by 10.37-71.39%. On the other hand, COD levels also decreased by 8.75-71.39%, and NH3 levels decreased by around 12.57-18.59%.

The contact time of treatment group II for 90 minutes is an effective duration. Contact time refers to the period of contact between wastewater and the media. The longer the contact time, the more pollutants will be captured by activated carbon and zeolite. This is believed to occur because the active sites become saturated with pollutants until the adsorption process reaches equilibrium. At this point, the opportunity for active sites on the surface of the adsorbent to capture pollutants diminishes. Once equilibrium is achieved, the adsorption of pollutants stabilizes in terms of the percentage of adsorbate, as the active groups on the surface of the adsorbent have been utilized (Muhammad, 2013).

The results of this present study also show that Group II, consisting of 1000 grams of zeolite and 2000 grams of galam wood charcoal (1:2), was the most effective treatment in reducing BOD, COD, and NH3 levels. These results suggest that the composition with a higher proportion of galam wood charcoal leads to better improvement in water quality parameters. This is due to the process of diffusion and attachment of solute molecules, which are adsorbed more effectively. On the other hand, zeolite is a coagulant that has the ability to bind to negative and small particles (Khaleque et al., 2020; Nugraheni et al., 2023). Furthermore, zeolite can neutralize these particles by forming small flocs and allowing them to settle. This precipitation results in a decrease in pollutants in the wastewater, which can be seen from the decrease in BOD, COD, and NH3 levels (Arita et al., 2022; de Magalhaes et al., 2022).

In general, this study aligns with the findings of Pungus et al. (2019), which indicated that the utilization of activated charcoal and zeolite can decrease the levels of COD and BOD in domestic wastewater. The study also elaborated on how media thickness and contact time play a significant role in influencing the treatment process.

This study has proven that the treatment method can effectively reduce pollutants from domestic waste. The findings of this study can be implemented in the community using models and scales tailored to the volume and discharge of wastewater. Nevertheless, further research is needed to explore this further.

In this study, there are several weaknesses, namely that sampling was carried out only in the morning. Therefore, in future studies, sampling needs to be conducted at various times, such as during the day and evening. Additionally, it should be compared with data from the riverbanks.

4. Conclusions

The results of this present study suggested that the combination of contact time and treatment in this wastewater treatment could increase water pH and decrease the BOD, COD, and NH_3 levels in wastewater. The decrease in BOD, COD, and NH_3 levels was seen below the standard quality limits set by the government but not the pH value. Also, the reduction of BOD, COD, and NH_3 and increased pH indicated that this treatment combination for 90 minutes or more can improve wastewater quality. The best combination of wastewater treatment in this study was seen in the combination of Galam wood charcoal and zeolite in a ratio of 2:1. While this finding is promising, further research is needed to optimize the method, such as investigating the effects of different contact times and treatment ratios, and ensure its widespread adoption as an alternative for improving water quality.

References

Abduraimov, S.B.U. 2021. Wastewater disposal systems and types of wastewater. International Journal on Orange Technology, 3 (9), 34-35.

Akinnawo. SO. 2023. Eutrophication: causes, consequences, physical, chemical, and biological techniques for mitigation strategies. Environmental Challenges, 107333, 1-18.

Anggraini, E., and I. Muzaidi. 2020. Pemanfaatan limbah kayu galam Barito Kuala sebagai pengganti agregat kasar pada campuran beton. Jurnal Konstruksi, 11 (2), 61-68.

Ardhana, A., Syaifuddin, D. Alimah. 2018. Pola pemanfaatan dan pemasaran kayu galam di Desa Jejangkit Timur dan Margasari, Kecamatan Marabahan, Barito Kuala, Kalimantan Selatan. Seminar Nasional Merawat Asa Restorasi Gambut, Pencegahan Kebakaran dan Peningkatan Kesejahteraan Masyarakat, 1 (2018), 187-195.

Arita, S., T.E. Agustina, N. Ilmi, V.D.W. Pranajaya, R. Gayatri. 2022. Treatment of laboratory wastewater by using fenton reagent and combination of coagulation-adsorption as pretreatment. Journal of Ecological Engineering, 23 (8), 211-221.

Asti, A.F., and D. Mayasari. 2023. Effectiveness of flood management policies in Sungai Pinang District, Samarinda City. Formosa Journal of Sustainable Research, 2 (3), 699-712.

Awewomom J., F Dzeble, Y.D. Takyi, W.B. Ashie, E.N.Y.O. Ettey, P.E. Afua, L.N.A. Sackey, F. Opoku, O. Akoto. 2024. Addressing Global Environmental pollution using environmental control techniques: a focus on environmental policy and preventive environmental management. Discover Environment, 2, 8.

Badawi, A. K., R.S. Salama, and M.M.M. Mostafa. 2023. Natural-Based coagulants/flocculants as sustainable market-value products for industrial wastewater treatment: a review of recent developments. The Royal Society of Chemistry Advance 13, 19335.

Bakkara, G.C., and A. Purnomo. 2022. Review of domestic wastewater treatment plants centralized in Indonesia. Institut Teknologi Sepuluh November Journal of Engineering, 11 (3), D75-D81.

Butler, J.B., I.W.B. Suyasa, and I.M.S Negara. 2022. Penurunan COD, BOD, TSS, Amonia dan koliform air limbah rumah potong hewan dengan biofilter aerobic-fixed-bed reaktor dan klorinasi. Journal of Chemsitry, 16 (2), 174-181.

Darmawan, J., T.D.K. Pribadi, J. Haryadi. 2021. The effect of gradual decrease pH level on the survival rate and glucose levels of catfish (*Pangasius sp.*). Aquaculture, Aquarium, Conservation, and Legislation Bioflux, 14 (3), 1231-1241.

Dewi, C., A. Saleh, N.H. Awaliyah, Hasnawati. 2018. Evaluation of emulgel formula of snail (*Achatina fulica*) slime and antibacterial activity test for *staphylococcus epidemidis*, the cause of acne. Jurnal Mandala Pharmacon Indonesia, 4 (2), 122-134.

Faradila, R., H.S. Huboyo, A. Syakur. 2022. Engineering domestic water treatment with filtration combination method to lower water pollutant levels. Jurnal Kesehatan Lingkungan Indonesia, 22 (3), 342-350.

Hamdan A.M., H. Yahya, S. Muharrami, R. Maulana. 2022. Quick sand filtration in restaurant waste treatment with coconut fiber and activated carbon media: application of Van der Waals force. Jurnal Riset dan Kajian Pendidikan Fisika, 9 (2), 76-87.

Harahap, J., T. Gunawan, S. Suprayogi, M. Widyastuti. 2021. A review: domestic wastewater management system in Indonesia. IOP Conf. Series: Earth and Environmental Science, 739 (2021), 012031.

Haryati, S., A.T. Yulhan, and L. Asparia. 2017. Pembuatan Karbon Aktif dari Kulit Kayu Gelam (Melaleuca Leucadendron) yang berasal dari Tanjung Api-Api Sumatera Selatan. Jurnal Teknik Kimia, 23 (2), 77-86.

Hayat, F. 2020. Analysis of free chlor (cl_2) levels and its impact on public health along the Cidanau River Cilegon City. Jurnal Kesehatan Masyarakat Mulawarman, 2 (2), 64-69.

Hidayah, E.N., Djalalembah, A., Asmar, G.A., dan Cahyonugroho, O.H., (2018), Pengaruh aerasi dalam constructed wetland pada pengolahan air limbah domestik. Jurnal Ilmu Lingkungan, 16 (2), 155-161. Jurnal Rekayasa Lingkungan, 12 (1), 41-57,

Khaleque, A., M. Alam, and M. Hoque, et al. 2020. Zeolite synthesis from low-cost materials and environmental applications: a review. Environmental Advances, 2020 (2), 100019.

Kuldeyev, E.I., Y. S. Orynbekov, Z. A. Mansurov, R.E. Zhumadilova, A.A. Murzagulova. 2023. Applicability of zeolite from the Daubabinsk and Chandania deposits as a sorbent for natural waters. Water, (15), 2231.

Kurniawati, E., and M. Sanudin. 2020. Filtration and adsorption methods with variations in contact time in processing batik liquid waste. Riset Informasi Kesehatan, 9 (2), 126-133.

Koul, B., D. Yadav, S. Singh, M. Kumar, M. Song, 2022. Insights into the domestic wastewater treatment (DWWT) regimes: a review. Water, 14, 3542.

Lin L., H. Yang, and X. Xu. 2022. Effects of water pollution on human health and disease heterogeneity: a review. Frontier Environmental Science, 10, 880246.

de Magalhaes, L.F., G.R da Silva, A.E.C. Peres. 2022. Zeolite Application in wastewater treatment. Adsorption Science and Technology, 2022, 1-26.

Magowo, E., C. Sheridan, K. Rumboid. 2020. Global co-occurrence of acid mine drainage and organic rich industrial and domestic effluent: biological sulfate reduction as a co-treatment option. Journal of Water Process Engineering, 38, 101650.

Maliga, I., Rafiah, A. Lestari, D.B. Pratama, D. Febriansyah. 2022. Counseling on household greywater wastewater management in efforts to improve the level of community health. ABDIKAN: Jurnal Pengabdian Masyarakat Bidang Sains dan Teknologi, 1 (2), 259-263.

Mariani, Masitah, and Herliani. 2021. Analysis of water quality in the Sungai Pinang Luar Sub-District in terms of the distribution of plankton as a bioindicator. Jurnal Ilmiah Biosmart, 1 (1), 52-65.

Manisalidis I, E. Stavropoulou, A. Stavropoulos, and E. Bezirtzoglou. 2020. Environmental and health impacts of air pollution: a review. Frontier Public Health, 8, 14.

Mohamad, E. (2013). Pengaruh variasi waktu kontak tanaman bayam duri terhadap adsorpsi logam berat kadmium (Cd). Jurnal Entropi, VIII (1), Inovasi Penelitian, 562-571.

Muzarpar, M.S., A.M. Leman, K.A. Rahman, N. Maghpor, N.N.M. Hassan, N. Misdan. 2020. the adsorption mechanism of activated carbon and its application - a review. International Journal of Advanced Technology Mechanic Mechatronics Mater, 1 (3), 118-124.

Nugraheni, P.W., L.T.N. Maleiva, F. Ramadhan, E. Kusumawardhani, L.S.A. Putra. 2023. Effectiveness Of well water treatment method with electrocoagulation, coagulation, and electrocoagulation-coagulation using alum as coagulant. IOP Conference Series: Earth Environmental Science, 1228, 012039.

Nurhayati, I., Ratnawati, R., and Sugito, (2019), Effect of potassium and carbon addition on bacterial algae bioremediation of boezem water. Environmental Engineering Research, 24(3): 495-500

Nurrosyidah, I.H., E.N. Putri, B.A. Sastria. 2023. Environmentally friendly detergent formulation with simplicia powder of waru leaves (Hibiscus tilliaceusl.) and lerak fruit (Sapindus rarakdc.) as surfactant. Jurnal Riset Kefarmasian Indonesia, 5 (1), 146-155.

Onyutha, C., E. Okello, R. Atukwase, P. Nduhukiire, M. Ecodu, J.N. Kwiringira. 2024. Improving household water treatment: using zeolite to remove lead, fluoride and arsenic following optimized turbidity reduction in slow sand filtration. Sustainable Environment Research, 34 (4), 1-15.

Pungus, M., Paililingan S., Tumimomor F. (2019). Penurunan kadar BOD dan COD dalam limbah cair *laundry* menggunakan kombinasi adsorben alam sebagai media filtrasi. Fullerene Journal of Chemistry, 4 (2): 54-60.

Ramadani, R., S. Samsunar, and M. Utami. 2021. Analisis suhu, derajat keasaman (pH), *Chemical Oxygen Demand* (COD), dan *Biologycal Oxygen Demand* (BOD) dalam air limbah domestik di Dinas Lingkungan Hidup Sukoharjo. Indonesian Journal of Chemical Research, 6 (1), 12–22.

Ramayanti D., and Amna U. 2019. Analisis Parameter COD (Chemical Oxygen Demand) Dan pH (Potensial Hidrogen) limbah cair di PT. Pupuk Iskandar Muda (PT. PIM) Lhokseumawe. Quimica: Jurnal Kimia Sains dan Terapan, 1 (1), 16-21.

Satria, A.W., M. Rahmawati, and A Prasetya. 2019. Processing ammonia nitrification and phosphate denitrification wastewater with submerged biofilter. Jurnal Teknologi Lingkungan, 20 (2), 243-250.

Setyawati, H., E.J. Sinaga, L.S. Wulandari, F. Sandy. 2018. Effectiveness Of Moringa seeds and aluminum sulfate as a coagulant on quality improvement liquid waste of tofu industry. Jurnal Teknik Kimia, 12 (2), 47-5i.

Shivsharan V.S., and M. Wani. 2017. Anaerobic-Aerobic activated sludge treatment followed by phytoremediation to dairy effluent. International Journal of Biotechnology Biochemistry, 13 (1), 67-72.

Sulistia, S., and Septisya AC. (2019). Analisis kualitas air limbah domestik perkantoran. Jurnal Rekayasa Lingkungan, 12 (1), 41-57.

Supriyati W., T.A Prayitno, Sumardi, and S.N. Marsoem. 2015. Local wisdom of utilization of gelam wood on peat swamp land of Central Kalimantan. Jurnal Manusia dan Lingkungan, 22 (1), 94-99.

Tarru, R.O., H.E. Tarru, W. Ekalisa, F.T. Wahyuni. 2021. Treatment of domestic liquid waste using filtration and adsorption methods at Villa Citra Makale Housing. Journal Eduvest, 1 (11), 1313-1321.

Utari, A.W., and H. Herdiansyah. 2020. Using filtration as a technology to remove pollutants in domestic wastewater. IOP Conference Series: Materials Science and Engineering, 725 (2020), 012025.

Warren-Vega, WM, A. Campos-Rodríguez, A.I. Zarate-Guzman, L.A. Romero-Cano. 2023. A current review of water pollutants in American continent: trends and perspectives in detection, health risks, and treatment technologies. International Journal of Environmental Research and Public Health, 20, 4499.

Widyarani, D.R. Wulan, U. Hamidah, A. Komarulzaman, R.T. Rosmalina, N. Sintawardani. 2022. Domestic wastewater in Indonesia: generation, characteristics, and treatment. Environmental Science Pollution Research International, 29, 32397-32414.

Wirosoedarmo, R., A.T.S. Haji, E.A. Hidayati. 2016. the influence of concentration and contact time in domestic sewage treatment using activated carbon, the cob of corn to reducing BOD and COD. Jurnal Sumber Daya Alam Lingkungan, 3 (2), 31-38.

Yehia, H.M.A.S., and S.M. Said. 2021. Drinking water treatment: ph adjustment using natural physical field. Journal of Bioscience and Medicine, 9, 55-66.

Zilfa, Rahmayeni, V.W. Wellia, Y. Yusuf, P.I. Ardica, S. Zahara, M.H. Reza. 2022. Penggunaan TiO_2/Zeolit untuk mengurangi konsentrasi nitrat, nitrit, amoniak, fosfat, BOD, COD, Dan pH air limbah pertanian secara fotolisis. Jurnal Katalisator, 7 (2), 277-297.