Reduce Oil in Domestic Wastewater Using Durio Zibethinus and Oryza Sativa

Siti Arinah binti Sanat [1,*], Rozilaili binti Mustapa [1], Shawalrina binti Zainal Abidin [1]

1 Jabatan Kejuruteraan Awam, Politeknik Sultan Idris Shah, Selangor, Malaysia

* E-mail: arinah_sanat@psis.edu.my

ABSTRACT

Waste cooking oil is a significant contributor to water pollution, originating from both domestic and industrial food preparation. This study aims to develop an oil trap and evaluate the effectiveness of durio zibethinus (durian) and oryza sativa (rice husk) as filtration media. These oil traps are engineered to separate and capture waste fats, oils, grease, and solids before they enter the wastewater system. The traps are installed at the terminal points of pipelines draining water from kitchen sinks. The study assesses the performance of the oil traps using specific parameters and the characterization of durio zibethinus and oryza sativa. The effectiveness of the oil trap is measured through various parameters, including physical properties like turbidity and chemical properties such as pH and oil and grease content. The study concludes with the successful development of an oil trap that has the potential to mitigate water pollution caused by oil waste.

KEYWORDS

Chemical properties; filtration media; oil trap; turbidity; water pollution

1. INTRODUCTION

Water pollution from domestic oil spills, such as waste cooking oil, is an increasingly pressing issue, primarily stemming from the improper disposal of cooking oils and fats. When these substances are washed down the drain, they enter the sewer system, where they can solidify and combine with other waste materials. This leads to the formation of fatbergs—large, solid masses of fat, oil, and grease (FOG) that obstruct sewers and cause significant environmental and infrastructural problems.

Fatbergs are notorious for causing severe blockages in sewer systems, leading to sanitary sewer overflows (SSOs). These overflows result in untreated sewage spilling into streets, homes, and natural water bodies, causing extensive environmental contamination and public health hazards. The contamination of water bodies by untreated sewage introduces pathogens and harmful chemicals into the ecosystem, posing risks to both aquatic life and human health (Wallace et al., 2017).

Moreover, the presence of oil and grease in water bodies can have long-term ecological impacts. These substances create a film on the water surface, reducing oxygen levels and hindering the survival of aquatic organisms. This can disrupt entire ecosystems, affecting biodiversity and the health of fish and other wildlife. Additionally, oil spills can impair water quality, making it unsafe for recreational activities and drinking water sources.

Addressing the issue of domestic oil spills requires effective FOG management strategies. This includes public education on the proper disposal of cooking oils and fats, the use of grease traps in households and commercial kitchens, and the implementation of community-wide recycling programs for used cooking oil. Successful examples of FOG management can be seen in cities like Dublin and Scandinavian countries, where comprehensive programs have been established to prevent FOG deposition in sewers and promote sustainable waste management practices.

Water pollution from domestic oil spills poses a significant threat to the environment and public health. By adopting proper waste disposal practices and implementing effective FOG management strategies, we can mitigate the adverse effects of domestic oil spills and protect our water resources for future generations(Wallace et al., 2017).

2.1 PROBLEM STATEMENT

Recently, issues related to fat, oil, and grease (FOG) in sewer systems have worsened. Media reports often highlight sewer blockages caused by FOG waste deposits, known as 'fatbergs,' which serve as a reminder of the problems untreated FOG waste can cause. These blockages lead to sewer overflows, property flooding, and water contamination with sewage. Despite the financial and environmental impacts, a uniform FOG waste management method hasn't been developed globally. However, successful FOG management programs exist in places like Dublin and Scandinavian countries. Effective FOG management involves understanding FOG deposition in sewers, implementing prevention and awareness strategies, and exploring potential uses for FOG waste(Wallace et al., 2017).

This type of wastewater can lead to significant environmental imbalances and pose serious risks to human health, including carcinogenic effects, and contamination of potable water and groundwater resources. Additionally, it can induce genetic mutations in flora and fauna, and escalate the chemical and biological oxygen demands (COD and BOD) in aquatic systems, thereby exerting diverse adverse impacts on aquatic ecosystems(Abuhasel et al., 2021; Yu et al., 2017)

In this study, an oil trap (grease trap) is designed to separate oil from water, preventing oil from solidifying and clogging drain pipes. Under Malaysian law, this device must be installed in households, restaurants, and canteens to prevent water pollution. Using an oil trap (grease trap) can effectively separate oil from water, solving the issue of pipe blockages. Many people cook high-fat foods and use cold water for washing, which causes fat to solidify in the pipes.

2.2 OBJECTIVE

The objective of this study are :

a) To develop an oil trap using *durio zibethinus*(durian) and *oryza sativa*(rice husk).

b) To evaluate the effectiveness of *durio zibethinus*(durian) and *oryza sativa*(rice husk) as filtration media.

2.3 SCOPE OF STUDY

Around 75% of domestic wastewater is produced by homes or residential buildings; the remaining 25% is produced by public spaces, businesses, office buildings, etc. (Mahendra & Wirawan, 2020). This research looks at how residential areas and IKS Kuala Selangor pollute water; it specifically looks at how to separate water and oil using creative grease traps. A device called an oil trap, sometimes known as a grease trap, keeps clogs in drain pipes by separating oil from water. The purpose of these traps is to lessen the pollution that everyday household and commercial activities cause in the water. In order to prevent water pollution, these devices are mandated by Malaysian legislation for both residential and commercial kitchens. The problem of fat, oil, and grease (FOG) in sewer systems has gotten worse recently, causing obstructions and pollution of the environment. Known as "fatbergs," these obstructions lead to sanitary sewer overflows and contaminate nearby bodies of water. Although there are serious financial and environmental consequences, there isn't a universal FOG waste management technique in place worldwide.

The aim of this research is to create an oil trap by utilising *Durio zibethinus and Oryza sativa*, and to assess the efficiency of these plants as filtration media. In order to avoid clogged sink pipes and lessen pollution in rivers, this study attempts to separate oil from water. Materials capable of isolating leftover air and trapping oil are identified before they are dumped into sewers. Easy-to-reach materials like durian bark, rice husk, and sea sand are used in the oil trap, which is situated at the end of kitchen sink pipelines. Because it doesn't require electricity to operate, it is both economical and environmentally beneficial. It is also made for simple installation and removal for cleaning. Physical (turbidity and colour) and chemical (pH) metrics are used to assess the oil trap's efficacy. (Kenes et al., 2014)

3 METHODOLOGY

Figure 1 shows the process of making an oil trap by using *Durio Zibethinus* (durian peel) and *Oryza Sativa* (rice husk). The primary materials used in this study were *Durio Zibethinus* and *Oryza Sativa*. Since rice is the third most widely grown cereal worldwide, rice husks are a plentiful agricultural waste product. Kenes et al., (2014) claim that rice husks are efficient oil adsorbents. In this study, durian was another type of agricultural waste used. Since durian peel has a high fibre content that aids in the adsorption process, using durian waste as an adsorbent would be feasible. One of the well-known fruits that is farmed, eaten locally, and exported to Malaysia and a few other South East Asian nations is durian.

The process started with both materials being thoroughly washed to remove any impurities and then dried in an oven at 100°C for 30 minutes to eliminate moisture content. Post drying, the materials were treated with sodium hydroxide to enhance the strength and durability of the particles. Following the preparation, the treated *Durio Zibethinus* and *Oryza Sativa* were mixed in appropriate proportions and molded into filters, forming a solid structure suitable for oil absorption.

The effectiveness of these filters in absorbing oil from wastewater was evaluated through a series of physical and chemical tests. The physical tests involved measuring the turbidity levels of the water before and after filtration to determine the filter's effectiveness in removing suspended particles. Water's turbidity, which indicates the presence of suspended particles, is a measure of its clarity. Chemical tests included assessing the pH level of the water to ensure that the filter did not significantly alter the water's acidity or alkalinity. Additionally, the concentration of oil and grease in the water was measured before and after filtration to evaluate the filter's oil absorption capacity. These comprehensive tests provided a detailed evaluation of the filter's performance in treating wastewater and reducing water pollution.

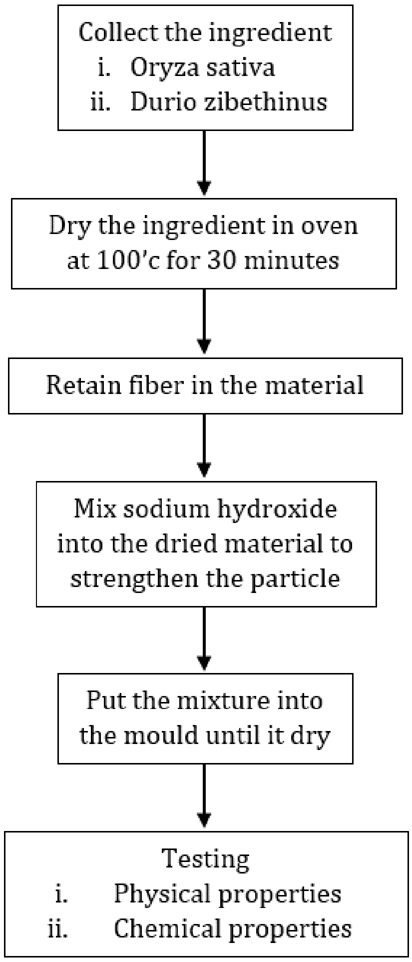

Figure 1. Proces of making oil trap

4 RESULTS AND DISCUSSION

Table 1 shows the results of physical and chemical properties tests. The physical properties test includes turbidity and color. While the chemical properties test includes pH, and oil and grease test.

Table 1. Result of physical and chemical properties

Table 2 shows the parameter standard of the Environmental Quality (Sewage) Regulation 2009. The parameter standards that in this study are pH, oil and grease.

Table 2. Standard of Environmental Quality (Sewage) Regulation 2009

No.	Parameter	Unit	Standard A	Standard B
1	**pH Value**	**-**	**6.0 – 9.0**	**5.5 – 9.0**

2	**Oil and Grease**	**mg/L**	**5.0**	**10.0**

Note: Standard A is applicable to discharges into any inland waters within catchment areas listed in the Third Schedule, while Standard B is applicable to any other inland waters or Malaysian waters.

(Source: Environmental Quality Sewage Regulations 2009, n.d.)

3. 1. 1 pH

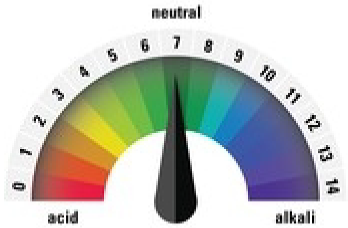

Figure 2. pH scale

The pH of the water samples before the experiment was 6.8, indicating a slightly acidic nature. After using *Oryza Sativa* (rice husk), the pH increased to 8.6, and after using *Durio Zibethinus* (durian peel), it increased to 8.3. When both materials were used together, the pH further increased to 8.9. Referring to Figure 2 and Table 2, the pH data shown that the water is alkaline which it is balanced and safe.

3. 1. 2 Color and Turbidity

Turbidity is the cloudiness or haziness of a fluid that is due to particles that are unseen to the unaided eye. One important way to examine the quality of the water is to measure the turbidity. According to the result in Table 1 which was obtained from the laboratory, the color of the water sample before the experiment was brown with a turbidity value of 100 NTU (Nephelometric Turbidity Units). After using Oryza Sativa, the color turned pale yellow with a turbidity value of 25 NTU. However, when *Durio Zibethinus* was used, the color turned yellow with a higher turbidity value of 50 NTU. After using both materials together, the color became pale yellow, and the turbidity was reduced to 10 NTU.

3. 1. 3 Oil and Grease Absorption

The oil and grease parameters in water samples before any treatment were measured at 52062 mg/L (milligrams per liter). After using *Oryza Sativa* as an oil trap material, there was a significant reduction in oil and grease absorption by approximately 94%. Ismail et al., (2020) also stated that *Oryza Sativa* has effective absorbent properties for oil in water. When *Durio Zibethinus* was used alone as an oil trap material, there was still an absorption rate but at a reduced percentage compared to *Oryza Sativa* (87%). However, when both materials were combined in an oil trap filter, there was an absorption rate of approximately 97%.

5 CONCLUSION

The conclusion of this study is that using *Durio Zibethinus* (durian peel) and *Oryza Sativa* (rice husk) as materials in an oil trap can effectively reduce oil and grease in domestic wastewater. The experiments conducted showed that both materials were able to absorb a significant amount of oil and grease, resulting in cleaner water with reduced turbidity and improved pH levels. Combining both materials in the oil trap filter resulted in the highest absorption rate. These findings suggest that implementing such oil traps can help prevent water pollution caused by household and small industries' waste, contributing to environmental protection.

Result Data	Before	Oryza Sativa	Durio Zibethinus	After (Oryza Sativa+ Durio Zibethinus)
pH	6.8	8.6	8.3	8.9
Color	Brown	Pale Yellow	Yellow	Pale Yellow
Turbidity	100	25	50	10
Oil & Grease	52 062 mg/L	3 193 mg/L	6 786 mg/L	1 560 mg/L
Percentage of Oil & Grease	control	94%	87%	97%

REFERENCES

Abuhasel, K., Kchaou, M., Alquraish, M., Munusamy, Y., & Jeng, Y. T. (2021). Oilywastewater treatment: Overview of conventional and modern methods, challenges, and future opportunities. *Water (Switzerland)*, *13*(7). https://doi.org/10.3390/w13070980

Environmental Quality Sewage Regulations 2009. (n.d.).

Ismail, U., Kamaruzaman, W. N., & Wil, Z. C. (2020). The Effectiveness of Oil Spill Remover in Marine Offshore from Rice Husk, Mango Peels and Durian Husk. *International Research Journal of Engineering and Technology*. www.irjet.net

Kenes, K., Yerdos, O., Zulkhair, M., Marat, T., & Yerbol, T. (2014). Rice husk ash for Oil Spill cleanup. *Applied Mechanics and Materials*, *446–447*, 1508–1511. https://doi.org/10.4028/www.scientific.net/AMM.446-447.1508

Mahendra, S., & Wirawan, S. (2020). Community Preparation for Domestic Wastewater Management Development in Jakarta. In *International Journal of Innovative Science and Research Technology* (Vol. 5, Issue 2). www.ijisrt.com

Wallace, T., Gibbons, D., O'Dwyer, M., & Curran, T. P. (2017). International evolution of fat, oil and grease (FOG) waste management – A review. In *Journal of Environmental Management* (Vol. 187, pp. 424–435). Academic Press. https://doi.org/10.1016/j.jenvman.2016.11.003

Yu, L., Han, M., & He, F. (2017). A review of treating oily wastewater. In *Arabian Journal of Chemistry* (Vol. 10, pp. S1913–S1922). Elsevier B.V. https://doi.org/10.1016/j.arabjc.2013.07.020