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Performance of Greywater Treatment Using Iron Removal Media (IRM) and *Cattail Typha Angustifolia*

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ABSTRACT

Water is essential to support daily life, ecosystem, environment, and development. Due to rapid industrialisation, population growth, and economic development, the water demand increases worldwide. For this reason, research is being conducted to find alternative sources of water for non-potable purposes. Domestic greywater is receiving much attention worldwide as a possible alternative water supply for domestic and productive purposes. This study aims to determine the water quality index (WQI) for domestic wastewater and evaluate the effectiveness of Iron Removal Media (IRM) and *Cattail Typha Angustifolia* plants in treating greywater. The domestic wastewater used for treatment was wastewater from laundry activities. There are two types of models designed to obtain different data for both media. The first model design is used with Iron Removal Media and the second model is with *Cattail Typha Angustifolia* plants. After the greywater treatments, the efficiencies of different treatments were observed and compared to the WQI standard. It was found that the removal efficiencies were 25% for biochemical oxygen demand (BOD), 23% for chemical oxygen demand (COD), 12% for total suspended solids (TSS), and 9% for pH using IRM. When *Cattail Typha Angustifolia* media was used, the removal efficiencies of 57% for TSS, 46% for COD, 45% for BOD, and 10% for pH were achieved. This study showed that using *Cattail Typha Angustifolia* plants as media for the greywater treatment process could be more effective as compared to IRM.

Keywords: Cattail Typha Angustifolia, greywater treatment, iron removal media, wastewater, water quality index

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INTRODUCTION

Freshwater is a vital resource as it is the primary drinking water supply for humans. Unfortunately, it is becoming a limited resource all over the world. Freshwater is scarce everywhere in the world and will continue to be so in the future. Due to population growth and current climate change, water scarcity will occur everywhere in the world (Huang et al., 2016; Sharma & Wasko, 2019). Even in developing countries where many people have access to abundant water, physical shortages occur in many places when local demand exceeds local supply (Matchaya et al., 2019). In addition, the rapid expansion of water-intensive agriculture in emerging economies and poor water management practices in developed countries are contributing to the global depletion of future freshwater resources (Emery et al., 2018; Mahmud et al., 2018).

Water management can help improve the quality of water for humans. Depending on the water quality at the source, the treatment can range from simple to complicated (Rosa & Ghisi, 2021). There is a growth in population and water consumption. However, the demand for water supply is not met sufficiently. Overconsumption of water and pollution from untreated wastewater from various sources threaten the current freshwater resources (Al-Husseini et al., 2021; Rosa & Ghisi, 2021). Based on the water crisis in Selangor in 2014, this problem needs to be addressed decisively (Sulaiman et al., 2020). Using or reusing wastewater can help reduce pressure on freshwater resources while avoiding the use of freshwaters that are not always necessary, such as irrigation, fish farming and recreation (Mir et al., 2017).

Therefore, it is necessary to minimise the use of surface and groundwater in all uses, replace freshwater with alternative water resources and increase the quality of water use through options of reusing water (Patankar et al., 2020). Such alternatives include rainwater and greywater. Greywater is generally defined as wastewater, excluding blackwater (i.e., toilet water). Greywater consists of used water from toilets, bathrooms, sinks, kitchen, dishwashers, washing machines and laundry tubs (Arifin et al., 2020; Byrne et al., 2020; Uddin et al., 2019). Soap, shampoo, toothpaste, food waste, cooking oils and detergents are made with it. Greywater accounts for the largest share of total wastewater discharged from households in terms of volume. Greywater contributes to 50-80% of domestic wastewater (Byrne et al., 2020; Nguyen et al., 2020).

Wastewater is mainly produced by residential, institutional, industrial and commercial sectors (Byrne et al., 2020; Nguyen et al., 2020). There are two types of wastewaters, namely domestic and industrial (Bani-Melhem et al., 2015). Domestic wastewater is water drained from households, commercial, institutional and public facilities such as toilets. In contrast, industrial wastewater is water drained from industrial areas, and water from this area may contain toxic substances depending on the industry (Gafri et al., 2018). Domestic wastewater can be divided into two main types, either blackwater or greywater (Ho et al., 2021; Jiang et al., 2009). Blackwater is wastewater from toilet usage, and greywater is from water used for washing (Ntibrey et al., 2021). The term greywater comes from its grey colour but still has a natural water quality, while black water is classified as wastewater (Al-Husseini et al., 2021; Patankar et al., 2020).

Laundry wastewater is composed of detergent additives, bleach, textile colour pigments and dirt (Ntibrey et al., 2021). Due to serious negative impacts on water bodies, such chemicals are hazardous once they enter the water supply without proper treatment (Li et al., 2009). For this reason, many environmental and health authorities require a certain number of surfactants in wastewater treatment before they can enter the environment. Laundry wastewater can be reduced by reducing pollution in the water supply or increasing the quality of the treated wastewater at treatment plants. In addition, due to the increasing availability of unpolluted water (water crisis), many scientists employ techniques to reuse and recycle polluted water. Potentially toxic chemical compounds produced during the household washing process can alter the natural water properties. Laundry wastewater typically contains a COD concentration of 400 to 2000 mg/L, depending on the type and concentration of detergent used (Al-Gheethi et al., 2017). While wastewater treatment is an old technology, the need to conserve water has increased in recent decades due to increasing water pollution and consumption.

Wastewater has been classified according to the source of generation; for example, laundry wastewater is one of the sources. Laundry wastewater is generated in households when washing textiles; it has a pH of about 5.6 and a chemical oxygen demand of about 4800 mg/L (Al-Gheethi et al., 2017). In addition, laundry wastewater contains an average of 0.08 mg/L total suspended solids, 0.037 to 0.72 mg/L iron and 94.65 mg/L phosphates (Jefferson et al., 2004). Some of these pollutants have been classified as threats to the local environment and toxic to humans. However, very little research has been done on adsorption methods to treat laundry wastewater. Instead, most research has focused on a conventional method called flocculation and coagulation using a chemical agent.

Total suspended solids (TSS), total dissolved solids (TDS), biochemical oxygen demand (BOD) and turbidity are basic water quality parameters for non-potable applications. Greywater is considered low to medium quality wastewater, and some nations have already begun to quantify and characterise greywater for successful greywater recycling. In developing countries, there is an increasing opportunity for wastewater reuse, such as greywater reuse, due to rapid industrialisation and development (Oteng-Peprah et al., 2018). However, due to rapid population growth and rising water consumption, stress on water resources is increasing, while the per capita water supply is dwindling. This research focuses on the characterisation and treatment of greywater and changes in water quality parameters.

One of the methods used for greywater is adsorption (Nguyen et al., 2020). The adsorption process has shown a high wastewater treatment capacity. This technology is simple, does not require toxic chemicals, and the end-users can use the adsorbents at home (Laaziz et al., 2021). When applying technologies to eliminate or mitigate greywater treatment, important factors should be considered. In developing countries, the use of low-cost technologies with removal efficiencies close to or above the permissible limit should be the technology of choice (Oteng-Peprah et al., 2018). In most cases, adsorption does not require initial treatment steps, and operating costs are relatively low. Adsorption is a cost-effective process, cited by the US Environmental Protection Agency as one of the best techniques for treating greywater (Singh et al., 2021). Adsorption is the most viable method for developing countries with limited economic conditions and infrastructures.

This study aims to determine the water quality index (WQI) for domestic wastewater and review the effectiveness of Iron Removal Media (IRM) and *Cattail Typha Angustifolia* plants in treating domestic wastewater. The domestic wastewater to be treated is wastewater from laundry activities. This water can be categorised as greywater. Several parameters are in focus, including dissolved oxygen (DO), TSS, BOD and COD.

METHODOLOGY

National Water Quality Standards (NWQS) are used as a guideline for water quality protection in Malaysia (Hasan et al., 2015). NWQS developed the water quality index (WQI) to classify and monitor water quality.

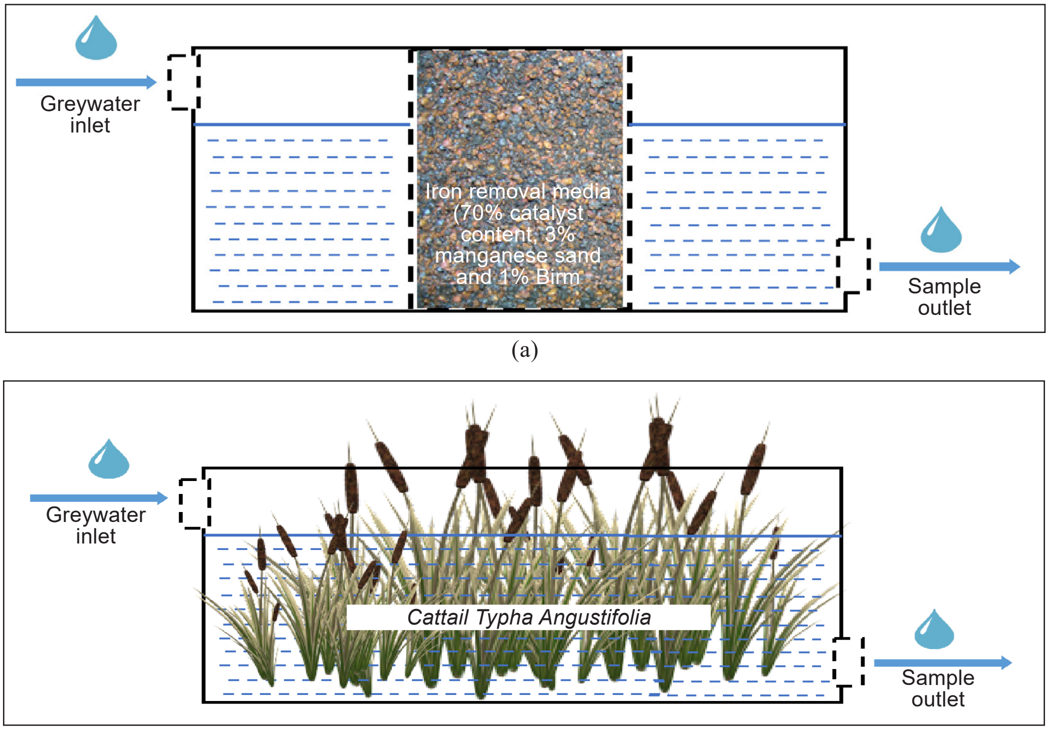
Study Area and Sampling

The wastewater samples from the laundromat were collected from Taman Universiti, Parit Raja (latitude 1°51’3.12 “N, longitude 103° 4’29.63 “E). The launderette was chosen because it is a self-service laundry that uses a variety of detergents with different dosages. Therefore, it is a perfect model to evaluate the effectiveness of natural coagulants. Samples from the discharge point were collected in high-density polyethene (HDPE) bottle and subjected to laboratory analysis to avoid deterioration of the detergent components. The pH, turbidity, COD and TSS of the laundry effluent were measured according to American Public Health Association (APHA) guidelines (APHA, 2017).

Model Design

In this study, Iron Removal Media (IRM) and *Cattail Typha Angustifolia* were used and compared for greywater treatment. Figure 1 illustrates the two types of design models.

These two media were chosen because they have different filtering capabilities. The Iron Removal Media (IRM) used contained a catalyst content of 70%, manganese sand of 3% and 1% of Birm. The media used can remove iron, manganese and hydrogen sulphide in the treated water. However, this medium requires the presence of sufficient dissolved oxygen in the water to act as a catalyst for oxidation to reach its maximum capacity. Table



(b)

Figure 1. Illustration of the model with (a) IRM and (b) *Cattail Typha Angustifolia*

Table 1
Features of Iron Removal Media (IRM)

Characteristics Description	Value
pH	5.0 - 9.0
Colour	Brown to black
Form	Granule
Effective size	0.3 to 0.6 mm
Catalyst	70%, manganese sand of 3% and 1% of Birm
Bulk density	25 kgs /15 litres

1 shows the characteristics of IRM for greywater treatment. IRM was obtained from the Laboratory of Environmental Engineering, Department of Civil Engineering, UKM. Figure 2 represents the treatment design using IRM.

Cattail Typha Angustifolia is a type of plant whose roots are planted in soft soil to penetrate the surface of the water. This plant is known as bulrush and belongs to the aquatic and semi-aquatic plants. It usually has a height between 1 to 3 metres and a size of 1 to 2 metres in diameter of the stem has several leaves between 12 to 16 pieces/tree. The leaves have a flat, upright, D-shaped surface with a width between 0.85 to 2 centimetres (cm).

Figure 2. Filtration design model using IRM

Figure 3. Filtration design model using *Cattail Typha Angustifolia*

Cultivation of *Cattail Typha Angustifolia* takes two weeks to ensure that the plant can function perfectly as a treatment agent. Samples for greywater after treatment by each medium were taken after being treated for seven days (Figure 3).

Table 2
Laboratory analysis procedure

Parameter	Analysis Procedure
pH	APHA 4500-H+ B "Electrometric Method"
DO	APHA 4500-O G "Membrane Electrode Method"
BOD	APHA 5210 B "5-Day BOD Test"
COD	APHA 5220 B "Open Reflux Method"
TSS	APHA 2540 D "Total Suspended Solids Dried at 103 – 105 °C"

Source: APHA, 2017

Analytical Methods

The performance of the model was measured regularly with tests for pH, dissolved oxygen (DO), total suspended solids (TSS), biochemical oxygen demand (BOD) and Chemical Oxygen Demand (COD) for inflow and outflow samples. All tests were repeated three times: for untreated wastewater, for wastewater treated with IRM and for wastewater treated with the cattail plants. Table 2 shows the standard procedure for laboratory analysis.

pH

The pH value was collected using a pH 300/310 hand-held meter by Eutech Instruments Pte Ltd/Oakton Instruments. This hand-held instrument is microprocessor-based and can measure pH, mV, and temperature. In order to measure the pH, the electrodes are dipped into the calibration buffer, and then the electrode is rinsed with de-ionised water or rinse solution. The probe shall not be wiped to avoid electrostatic charge existence on the glass surface. Then, the electrodes are immersed into the sample and stirred to achieve a homogeneous sample. Finally, the pH reading will appear on the LCD after pressing the red button.

Dissolved Oxygen (DO)

The DO is measured using a microprocessor-based Model 5000 Dissolved Oxygen Meter by YSI. This instrument has internal memory for 100 data points with auto stabilisation features which give the DO a stable reading. The total amount of gaseous oxygen dissolved in an aqueous solution is measured by the dissolved oxygen (DO) test (Department of Environment, 2010). DO is commonly used in water quality studies and the daily operation of water treatment plants (Ghaly et al., 2021). Dissolved oxygen in water bodies is crucial for the survival of organisms and living things. When oxygen is dissolved at a high level, this leads to a high concentration of nutrients.

Total Suspended Solid (TSS)

Solids in wastewater are defined as suspended or dissolved substances that can negatively affect the quality of water or wastewater in various ways (Prasad et al., 2021). Water with a high concentration of dissolved solids has low palatability and can cause an adverse physiological response in the transient user (Szymanski & Patterson, 2003). Therefore, physical treatment is the most effective method for treating TSS in wastewater. TSS is measured by defining the sample volume before and after the filtration process through the filtration apparatus. First, the weight of a microfiber filter paper oven-dried for one hour was measured. Then, the filter paper was stuck on the filter holder placed on the filter flask. Next, a sample of 50-100ml was poured onto the filter paper, and suction was applied to the sample through a vacuum pump attached to the filter flask. The sample will immediately flow through the filter paper and holder and drip into the filter flask. Then, the filter paper was removed from the apparatus and oven-dried for one hour. The difference in the weight of filter paper before and after the suction indicated the TSS of the samples.

The total suspended solids (TSS) were calculated using Equation 1:

$$TSS = \frac{(A - B) \times 1000}{V} \quad [1]$$

where:
A = weight of filter + dried residue (mg);
B = weight of filter (mg); and
V = sample volume (50 ml).

Biochemical Oxygen Demand (BOD_5)

The BOD_5 analysis is an empirical test that uses standardised laboratory techniques to estimate the relative oxygen demand of wastewater, faecal matter and contaminated freshwater (Utaberta et al., 2015). The test determines the molecular oxygen demand for biochemical degradation of organic material (carbon demand) and the oxygen demand for the inorganic oxidation material such as sulphides and iron over a defined incubation period. Obtaining the amount of 5-day BOD involved several procedures. First, the reagents such as phosphate buffer solution, magnesium sulphate solution, calcium chloride solution, and ferric chloride solution need to be prepared. Then, all the prepared reagents are diluted with dilution water with the ratio of 1:100 for sample and water. After that, the diluted sample was divided and filled into 5 BOD bottles. The initial reading of dissolved oxygen (DO) is determined from the first bottle, while others are tightly closed with the stopper and incubated for five days at 20^{o}C. The reading of DO for the remaining bottles was checked every day until day 5. For the controlling purposes, five days of DO reading should be done for dilution water which is considered a blank sample. Therefore, the reading of the blank samples will be compared to the real samples accordingly. The DO is measured using a microprocessor-based Model 5000 Dissolved Oxygen Meter by YSI. The biochemical oxygen demand after *five* days (BOD_5) was calculated with Equation 2:

$$\mathrm{BOD}_5 = \frac{DO_0 - DO_5}{P} \quad [2]$$

where:
DO_0 = DO of the diluted sample taken immediately after preparation, mg/l;
DO_5 = DO of the diluted sample after 5-day incubation at 20 C, mg/l; and
P = decimal volumetric fraction of the sample used.

Chemical Oxygen Demand (COD)

The amount of a particular oxidant in a sample under controlled conditions is called Chemical Oxygen Demand (COD). The amount of oxidant consumed is measured in oxygen equivalent units (Zaiedy et al., 2016). COD is a commonly used metric for measuring contaminants in wastewater and natural waters. Obtaining the concentration of COD is starts with the preparation of reagents such as potassium dichromate solution, sulphuric acid, phenanthroline indicator solution, standard ferrous sulphate (FAS) titrant, and mercuric sulphate. First, mercuric sulphate solution was diluted with the sample in a flask, and potassium dichromate solution was added while stirring the sample. Then, the sulphuric acid reagent was added into the flask, and the mixture was refluxed for 2 hours in the reflux apparatus. Next, the reflux apparatus was stopped, and the mixture was let to cool down at room temperature. The titration process takes place when titrating FAS into the flask while stirring the mixture. The mixture turned to blue-green colour and changed to reddish-brown. The FAS titration process was stopped when the colour of the mixture changed to reddish-brown. Then, the volume of FAS that was titrated into the mixture was measured. The same procedure of refluxing and titrating blank distilled water containing the same reagents and a volume equal to the sample was repeated. The COD value can be obtained using Equation 3.

$$\mathrm{COD} = \frac{(E-F)\times M\times 8000}{V}, \text{ with } M = \frac{C\times 0.25}{D} \quad [3]$$

where:
E = volume of ferrous ammonium sulphate (FAS) used for the blank (ml);
F = volume of FAS used for the sample (ml);
M = molarity of FAS;
V = volume of sample (ml);
C = volume of 0.04617M $K_2Cr_2O_7$ solution titrated (ml); and
D = volume of FAS used in the titration (ml).

Performance of Treatments

When investigating the qualitative performance of greywater treatment, the reduction values of the influent pollutants were determined by calculating the percentage removal according to Equation 4:

$$Removal\ (\%) = \frac{E_0 - E_1}{E_0} \times 100\% \quad [4]$$

where:
E_0 = concentration of the initial sample, mg/l; and
E_1 = concentration of sample after treatment, mg/l.

Water Quality Index Analysis

The water quality index technique, which is similar to that used in Malaysia, has been used in a number of countries. The National Water Quality Standard (NWQS) is a set of guidelines to maintain river water quality in Malaysia (Gafri et al., 2018). The water quality index (WQI) for the laundry wastewater treatment was calculated using five water quality parameters: dissolved oxygen (DO), five-day biological oxygen demand (BOD_5), chemical oxygen demand (COD), suspended solids (SS) and pH (Department of Environment, 2010). The WQI results were used to classify water quality in Malaysia according to the NWQS (Hasan et al., 2015; Mir et al., 2017). All parameters were multiplied by their specific index, as depicted in Equation 5.

$$\text{WQI} = [0.22\ \text{SIDO}] + [0.19\ \text{SIBOD}] + [0.16\ \text{SICOD}] + [0.16\ \text{SISS}] + [0.12\ \text{SIpH}] + [0.15\ \text{SIAN}] \quad [5]$$

where:
SIDO = subindex of dissolved oxygen;
SIBOD = subindex of biochemical oxygen demand;
SICOD = subindex of chemical oxygen demand;
SISS = subindex of suspended solid;
SIpH = subindex of pH; and
SIAN = subindex of Ammoniacal Nitrogen.

Different WQIs are formulated for different purposes, such as general water quality assessment, specific types of water demand and water quality management projects. However, one of the major challenges in developing WQIs is the selection of appropriate parameters that represent general water quality (Aghlmand & Nezami, 2021). Most developed WQIs are subjective in parameter selection, which affects the suitability of the index for a particular end-user (Mallick et al., 2021).

In this regard, only five selected parameters were considered, and a reprocessing process regulated the physico-chemical parameters. Similarly, the DO, BOD, COD, SS, and pH were considered slightly more than the treated parameters. However, Ammoniacal Nitrogen (AN) was not removed during the conventional wastewater treatment process, but only through elaborate techniques such as flotation and modified philtres (Lós et al., 2020; Nguyen et al., 2020).

RESULT AND DISCUSSION

The result is shown in Figures 2 to 6 with IRM and *Cattail Typha Angustifolia* as filters show the percentage reduction in laundry wastewater quality after IRM and *Cattail Typha Angustifolia*. The high concentration of BOD and COD in the laundry wastewater before treatment indicates contamination. Surfactants and builders were used in the laundry products, which contributed to the high concentrations of BOD and COD. Surfactants such as Alkyl Benzene Sulfonate, Linear Alkyl Benzene Sulfonate and Alpha Olefin Sulfonate, Texapon (Sodium Lauryl Ether Sulphate) and nonylphenol and builders such as Sodium Tripolyphosphate are commonly used in laundry detergents (Al-Gheethi et al., 2017; Li et al., 2009). Detergents contain organic chemicals that increase the BOD and COD content in the water system (Ghaly et al., 2021).

Comparison of pH

The pH of greywater is mainly determined by the pH and alkalinity of the water source, typically between 5 and 9. Due to the alkaline elements used in detergents, greywater, usually comes from laundry, often has a high pH. Surfactants are the most common chemical components in greywater from the cleaning or washing processes. Most cleaning solutions use these surfactants as the primary active ingredient. The reduction rate can be observed in the pH test. All data from the pH test was collected at a temperature of 25°C. After treatment, it was found that the pH had increased for all samples, as shown in Figure 4. It was found that the pH of the greywater treatment was between 7.5 and 7.6. The experimental results showed that the pH was successfully reduced by 8.69% with IRM and 9.76% with *Cattail Typha Angustifolia*. The pH of the water was still higher than the standard, according to WQI.

Comparison of DO

The most important element, especially for drinking water, is dissolved oxygen (DO). Figure 5 shows the DO value observed. After greywater treatment, the amount of oxygen in the water was also increased. The DO test showed an increase of 1.91 % for IRM and 1.27 % for *Cattail Typha Angustifolia*.

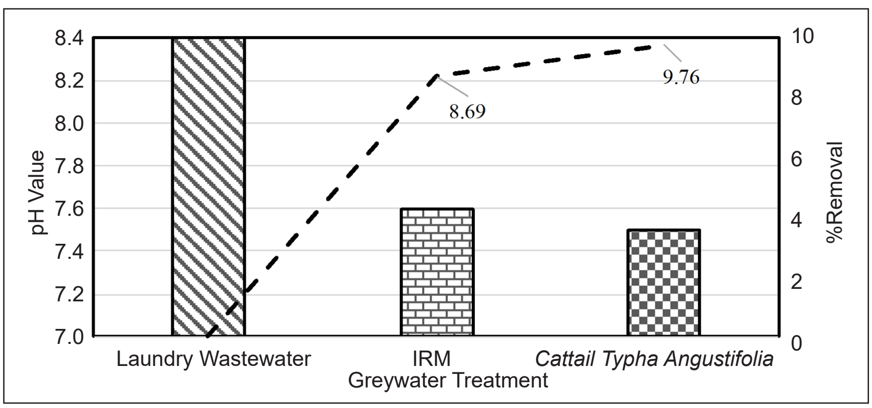


Figure 4. Comparison of pH values for different greywater treatments

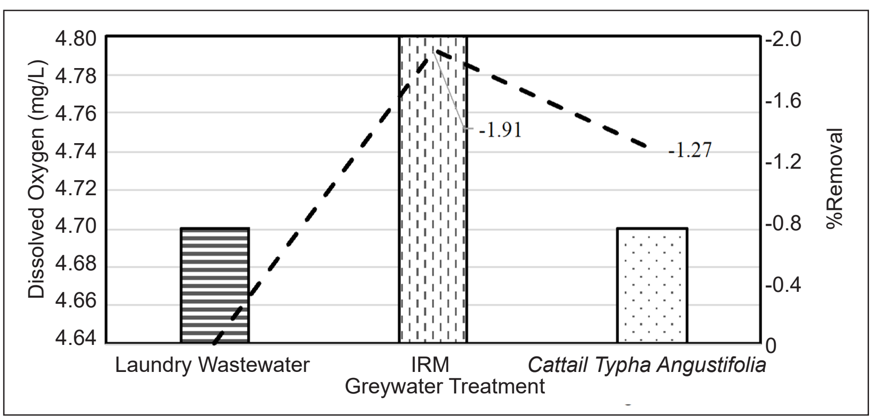


Figure 5. Comparison of dissolved oxygen values (DO) for different greywater treatments

Comparison of TSS

Greywater coming from the laundry has a relatively high total suspended solids (TSS) content, which may be due to the washed laundry, which may contain sand, clay and other elements that can increase the TSS. Due to the presence of suspended solids, greywater from the laundry is predicted to become more turbid. Figure 6 shows that the percentage removal of total solids is 12.50% and 57.14% for IRM and *Cattail Typha Angustifolia,* respectively. It corresponds to a 50% reduction in physical pollutants in the laundry effluent. Suspended solids in laundry wastewater are mainly sodium-based laundry chemicals in detergents and water-soluble bleaches, which require special separation technology.

Greywater from laundry can lead to high solid content in greywater, which causes turbidity and may result in clogging of pipes, pumps and filters used in the treatment processes. Also, powdered detergents and soaps, as well as colloids, are the main reasons for physical clogging. A study conducted by Oron et al. (2014) showed that the range of suspended solids concentrations in greywater is within 50–300 mg/L but can be as high as 1,500 mg/L in isolated cases.

Comparison of BOD

Surfactants, which are hydrophobic organic molecules found in wastewater, increase the oxygen demand of microbes to break down these organic substances, leading to an increase of BOD in the water. Compared to the efficiency of greywater treatment, *Cattail Typha Angustifolia* was found to reduce more BOD_5 than IRM. The detailed results can be found in Figure 7.

Comparison of COD

Figure 8 shows that the percentage removals from COD are 23.35% and 46.03% for IRM and *Cattail Typha Angustifolia,* respectively. With the increase in laundry services, the

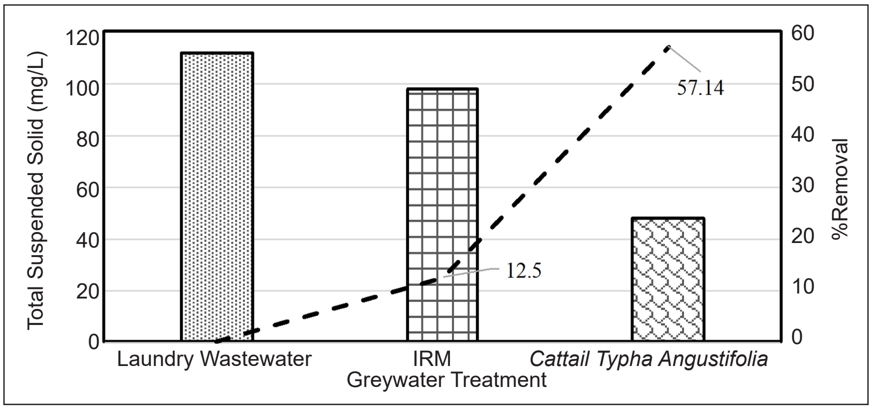


Figure 6. Comparison of total suspended solids (TSS) for different greywater treatments

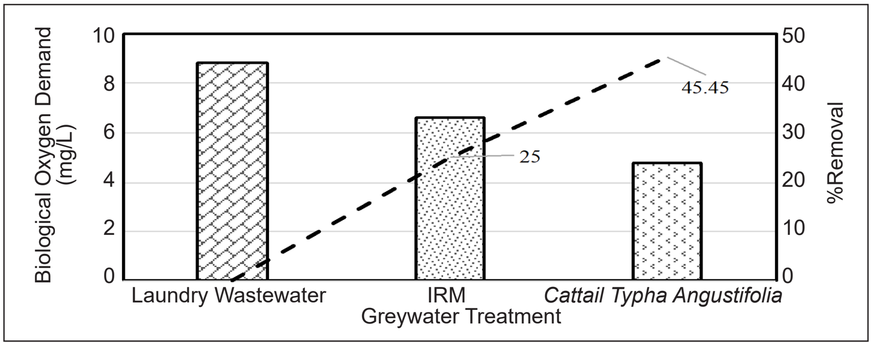


Figure 7. Comparison of biological oxygen demand (BOD) in different greywater treatments

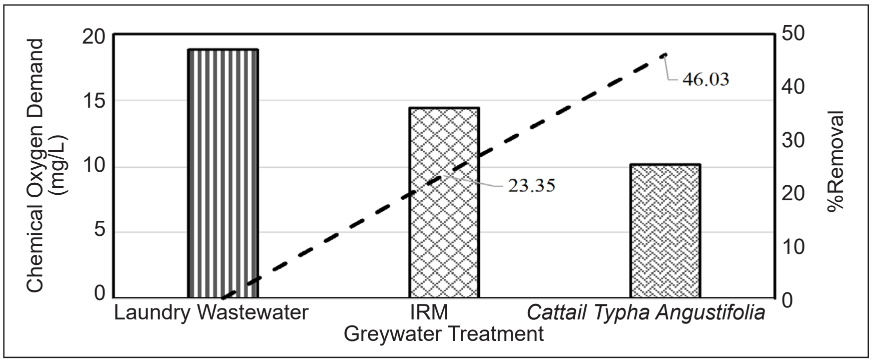


Figure 8. Comparison of chemical oxygen demand (COD) and performance of greywater treatment

laundry products and chemical content are used in the laundry products. Carbonic acid is used in wastewater treatment, and the biochemical and physical processes that occur during treatment affect carbon dioxide and bicarbonate concentrations (Gross et al., 2006). In this study, the highest reduction of TSS using *Cattail Typha Angustifolia* showed that this system effectively reduces the solid content in the laundry effluent solely through sedimentation and filtration processes. The efficiency of the solid filtration system in treatment is influenced by the pore diameters of the filtration systems (Muhamad et al., 2021). Smaller solid particles are not filtered or retained by larger pore diameters. When filtering TDS, the treatment system was more than 50% efficient. However, the treatment is more effective in reducing TDS when the pores of the media are small.

Water Quality Index (WQI)

Wastewater is classified according to the Department of Environment (DOE) Malaysia standards. The status of the effluent reflects the water quality of the effluent. The calculated value of mean WQI for laundry wastewater before and after treatment is shown in Figure 9. The changes in WQI classes can be seen for the parameters TSS and BOD for treatment with *Cattail Typha Angustifolia*. For TSS, class III to class II treatment with *Cattail*

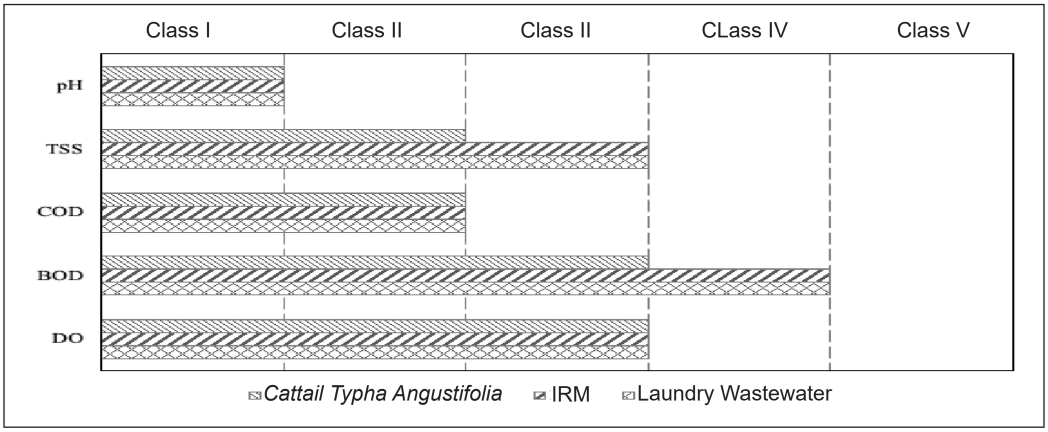


Figure 9. Comparison of the WQI class before and after greywater treatment

Typha Angustifolia can be a comprehensive treatment for laundry effluent and is suitable for sensitive aquatic species in the river system. For BOD, before treatment is class IV, the wastewater can only be used for plantation irrigation and not for water supply. After treatment with *Cattail Typha Angustifolia*, the wash effluent was changed to class III, suitable for fishery type III (economically valuable and tolerant species) and livestock irrigation.

Greywater treatment also includes storage, which can be a very efficient method of reducing BOD_5 levels. Disadvantages of storing raw greywater include increased odour and thermotolerant coliforms before they gradually decrease. Garden irrigation, toilet flushing, and irrigation are the most common alternatives to greywater reuse. As with any contemporary technology, cost reductions are inevitable with greywater reuse methods. It is a key element that can make greywater reuse a very popular method of water conservation in both developed and developing countries. Apart from the financial benefits of greywater reuse, another significant advantage is the water savings from an environmental perspective. Greywater reuse is a sustainable development that positively impacts long-term water management.

The migration of pollutants during greywater treatment and the subsequent development of retention measures have led to the use of adsorption, along with other techniques (N'diaye et al., 2021). Adsorption equilibrium information is the most important information to properly understand an adsorption process (Ebrahimi et al., 2021; Sanou & Pare, 2021; Talaiekhozani et al., 2019). Proper understanding and interpretation of adsorption isotherms are crucial for the overall improvement of adsorption mechanisms and the effective design of adsorption systems.

Several WQIs have been formulated, and efforts have been made to address the practical limitations. All developed WQIs have advantages and limitations, but the limitations could be minimised by reducing subjectivity. To date, no single WQI has gained global acceptance, but some countries have used a combination of water quality data in their formulation. This study reduced the uncertainty to the lowest level by separately adopting established water quality guidelines (INWQS) for physico-chemical parameters.

CONCLUSION

Water conservation is an important strategy to preserve the quality and quantity of water. Conservation is the act of collecting and managing water that falls to the ground. These measures store enough water to prevent a damaging drought during the dry season. Any treatment of a piece of land affects the water system on that piece of land as well as places downstream. Soil and water conservation are two issues that are intertwined. Water conservation is one part of various soil conservation efforts and vice versa. Another essential part of water conservation is recycling surplus water; residual water can be reused, and water consumption is reduced.

In summary, greywater from laundries currently has a class III for DO and TSS, a class IV for BOD and a class V for COD without filtration. IRM and the Cattail plant can help reduce COD, BOD and TSS. The WQI class was changed from class IV to class III after treatment with *Cattail Typha Angustifolia,* where it can be used as a biofilter to treat the laundry effluent. The study proposes a cost-effective greywater treatment technology to address economic water scarcity. Greywater treatment using *Cattail Typha Angustifolia* resulted in good removal of virtually all wastewater parameters studied, with the effluent minimally meeting the requirements for reuse in the water supply. Careful work on optimising the biofilter can make greywater reuse a cost-effective asset in the overall water budget and a viable option for household water conservation everywhere.

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