Greywater and POME: Characteristics and Treatment Analysis

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Abstract – *Increasing human activities is one of the factors that contribute to the increase in the waste generation, and one option for better waste management is by recycling the waste for other applications. This work studied on the potential of waste materials in improving the quality of greywater and palm oil mill effluent. The agricultural waste materials used were coconut coir, sugarcan bagasse, and plastic wastes, and results were compared with those obtained using charcoal. The media were soaked in the wastewater for 30 minutes, and the reductions in the total suspended solid (TSS), the turbidity and the total organic carbon (TOC) were measured. For the greywater, the highest reduction of TSS and turbidity was found for charcoal, of 38% and 60%, respectively, while the highest reduction of TOC was found for plastic estimated about 37%. For POME, results showed that the highest reductions of TSS and turbidity were found for coconut coir, of 34% and 35%, respectively, while the highest reduction of TOC was found for charcoal estimated to be about 42%. It was also found that TSS and turbidity showed a strong correlation, which showed the proportionality of both parameters, but weak correlation found between TSS and TOC.*

***Key Words*: Wastewater, greywater, palm oil mill effluent and biofilter**

1. INTRODUCTION

There is no argument about how essential cleanwater to life. The increasing of human activities relate to the increasing pollution around the world resulting to freshwater scarcity and demand for freshwater. Most of the water in the world, about 97.5%, is stored in the oceans and seas, while only the remaining 2.5% is available as freshwater, and 68.7% out of this small percentage of freshwater is tied up in glaciers and permanent snow covering the polar regions, greenland, the Arctic islands and mountain ranges (Uitto, 2001). The freshwater, which is available for human use available in deep aquifers, rivers, lakes, reservoirs and shallow aquifers. In Sarawak, Malaysia, rivers are the major resources for freshwater supply (Ummi et al., 2010), and therefore, maintaining good quality of the rivers' water is critical. A continuous discharge of untreated grey water can be one of the causes that pollute Sarawak rivers; study by NREB (2004) and Mah et al. (2007) shows that the water quality of rivers in Sarawak is deteriorating.

Water pollution comes from the municipal wastes, industrial wastes and agricultural wastes. Municipal wastes is the combined blackwater that comes from the toilets and greywater that comes from other sources in the house such as bathroom, kitchen and washing machine. Agricultural waste comes from the chemicals used in the ferterlizers, pesticides and herbicides as well as the animal waste, and industrial wastes comes from the processes and activities at the industry. Blackwater usually goes to sewage or septic systems, while the water discharged from industries is usually monitored by implementing wastewater treatments to ensure the wastewater quality is within the allowable limits set by the Department of Environment.

Greywater, is usually discharged to the drain without treatment, and in a long term, this practice can affect the quality of rivers' water because the drains are connected to water bodies such as rivers. Greywater contains combined chemicals and compounds such as sodium, phosphate, ammonia, nitrogen,phosphorus, oil and grease from the syampoo, the soap, the detergent, the oil and so on. Studies on greywater characteristics showed that greywater contains high total suspended solid (TSS), total organic carbon (TOC), Turbidity, Biological Oxygen deman (BOD) and Chemical Oxygen Demand (COD) (Leong et al., 2018; Al-Mughalles et al., 2012 and Al-Mamun et al., 2009). Mohamed et al (2014) reported that the use of solid soap contributes to the high TSS, BOD, and COD exceed the recommended value of 250mg/L. Some findings in the literature give an estimate of grey water quality within range of pH, BOD, COD, suspended solid, turbidity and content of oil and grease between 5-10, (26-530) mg/L, (48-8000) mg/L, (14-370) mg/L and (280-8000) mg/L, respectively (Mohamed et al. (2014); Imhof and Muhlemann, (2005) and Al-Mughalles et al. (2012)).

One of the methods that is applicable for treating greywater is biofiltration, which combines the filtration and the biological treatment. Microorganisms attach, colonize, develop the biofilm on the surface of the filter and biodegrade the water pollutants. Davies (2005) discussed the mechanisms and reactions involved in the biodegradation of polllutants by the microorganisms. The biofilter can be plastic, ceramic and so on that will allow the growth of microorganism. Wang et al. (2014) found out that the commercial media performed better than the natural resources in removing iso-pentane. They compared the removal efficiency of iso-pentane using natural resources, peat oil and compost with the synthesized support media, celite pellets and cordierite monolith. Other work on biofiltration using peat soil has also been done by Radin et al. (2013, 2014). Although, natural media may not be as good as the commercialzed ones, its application discussed here can be a potential approach to reduce the amount of waste material. In Sarawak, Malaysia, little has been done to reuse the plastic waste and agricultural waste, and research on adding value to these waste may contribute to a better waste management; currently, these wastes are mostly dumped in landfill.

In this work, the potential of different media in improving the quality of greywater and palm oil mill effluent (POME) was compared and studied. The media used were coconut coir, sugarcan bagasse, charcoal and plastics. The characteristics of the media was analysed using Fourier Transfrom Infra Red (FTIR), and the water quality was measured based on the measurement of the total suspended solid (TSS), turbidity and total organic carbon (TOC).

2. MATERIALS AND METHODS

The wastewater was collected in several locations of cafeteria and residential college at the University Malaysia Sarawak. The wastewater was characterized using the Shimadzu Fourier Transform Infrared Spectrophotometer (FTIR), and the water analysis was done by measuring the turbidity using a Turbidimeter TN-100 by Eutech Instruments, the total suspended solid (TSS) using TSS HACH DR9000 Multiparameter Handheld Colorimeter and the total organic compound (TOC) using Shimadzu Total Organic Carbon Analyzer TOC-LCPH/CPN.

The media was prepared from sugarcane bagasse, which was dried in the oven for 2 hours at 105°C, shredded coconut coir, crushed charcoal and plastic bottle, which was cut in rectangular pieces of 5x1 cm^2. The media were kept in separate 500 ml plastic bottles that were cut at its bottom part, and the opening at the bottles neck was covered with cotton cloth. The media were soaked in the wastewater inside the bottles that were hold up side down using tripods for 30 minutes. The mixture of media and waswater was stirred every 5 minutes to allow better oxygen flow inside the bottles.

3. RESULTS AND DISCUSSIONS

The spectroscopy for the greywater is illustrated in Figure 1. The peaks observed in the fingerprint region refers to compounds with the presence of C=O and C=H bonding, while those within the region between 3000 -3500 relate to compounds with the presence of C-H, N-H and O-H bonding. This result suggests that greywater contains compounds in the functional groups of alcohol, alkane, alkene and amide that make up some of the chemicals used in the soap, syampoo, toothpaste and so on.

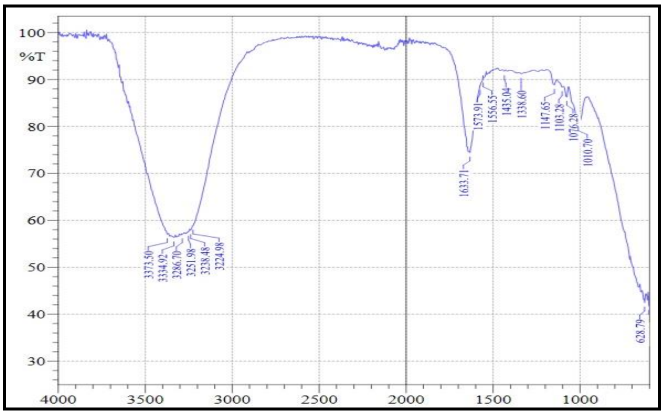

Figure 1: Spectroscopy graph of GW

Figure 2 shows the spectroscopy for the palm oil mill effluent (POME). The peak occurs for regions between 628 - 1633 indicate the existence of alkene, ester, amine, ether, aldehyde, ketone, carboxylic acid, benzene and nitro compounds. Those peaks within the peaks of 3000 – 3500 associated with alkane, alcohol and amide groups. Result obtained here correlate with the description by Rupani et al. (2010), who stated that POME contains organic acids, protein, carbohydrate, nitrogenuous compounds and lipids.

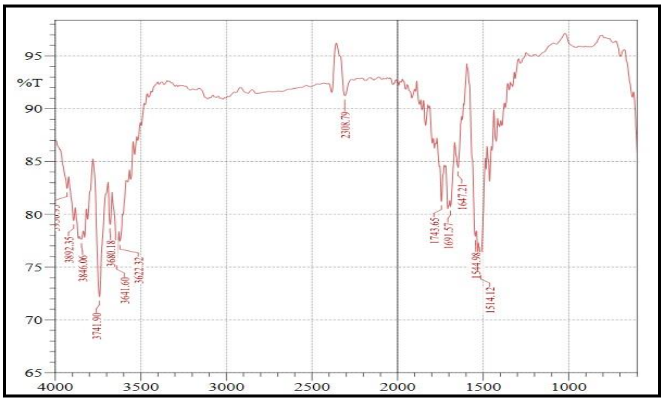

Figure 2: Spectroscopy graph of POME

Table 1 shows the percentage reductions of TSS, Turbidity and TOC for the greywater and POME that are plotted in Figures 3-5. For the greywater the highest reduction of TSS was found for charcoal, estimated about 38%, followed by plastic, then sugarcane bagasse and coconut coir of 27%, 20% and 14 %, respectively. The fibrous nature of sugarcane bagasse and coconut coir contributed to the suspended solid, shown by the smaller percentage of reduction compared with those obtained for charcoal and plastic. A similar trend of result was obtained for the measurement of turbidity. The percentage reductions of turbidity were estimated to be about 60%, 43%, 33% and 32% for charcoal, plastic, coconut coir and sugar cane bagasse, respectively. However, a different result was obtained for the reduction of TOC, which was found the highest for plastics of 37%, and then coconut coir of 24%, sugarcan bagasse of 23% and the lowest was for charcoal of 15%.

Data for POME in Table 1 shows that the highest reduction of TSS was found for coconut coir, estimated about 34%, followed by sugarcan bagasse, then charcoal and plastic of 20%, 17% and 1 %, respectively. A similar sequence of media was obtained for turbididty. The percentage reduction of turbidity were estimated to be about 35%, 22%, 8% and 5% for coconut coir, sugar cane bagasse, charcoal and plastic, respectively. However, a different result was obtained for the reduction of TOC, which was found to be the highest for charcoal of 42%, and then sugarcan bagasse of 35%, plastic of 33% and the lowest was for coconut coir of 14%. The different chemicals make up of the wastewater could be the reason to the different result obtained for POME compared to those found for the greywater.

Table 1: TSS, Turbidity and TOC percentage reduction

Media	% TSS Reduction		% Turbidity Reduction		% TOC Reduction	
	GW	POME	GW	POME	GW	POME
Sugarcane bagasses	20	20	33	22	23	35
Coconut coir	14	34	32	35	24	14
Plastic	27	1	43	5	37	33
Charcoal	38	17	60	8	15	42

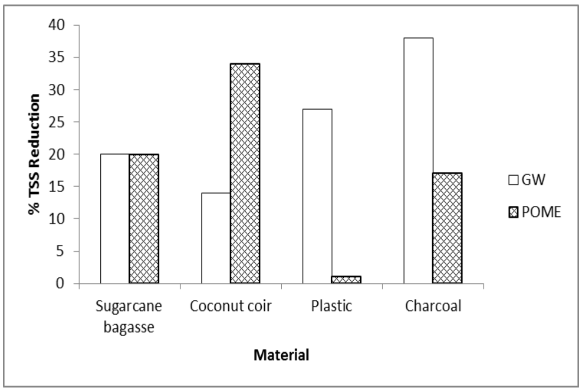

Figure 3: TSS reduction for different media

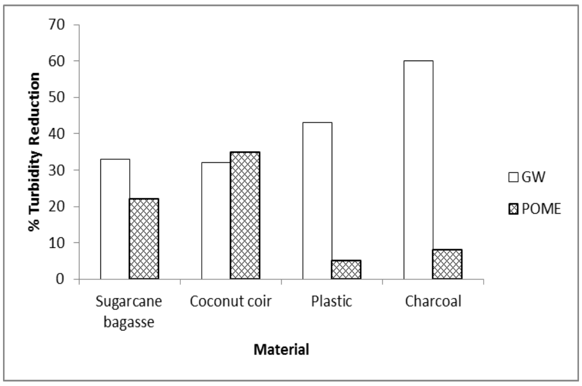

Figure 4: Turbidity reduction for different media

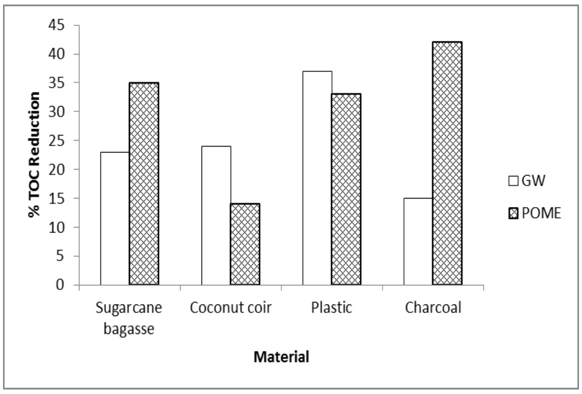

Figure 5: TOC reduction for different media

The high reduction of TOC found for plastic may be interpreted further by the results shown in Figure 6, which illustrated the TOC measured for greywater at different time. It was found that the percentage reduction of TOC increases almost exponentially with time that can be described using Equations 1 and 2. Here, y refers to TOC reduction (%), and t refers to time (mins). Result obtained here may indicate that plastic is a suitable material for microbe growth that consume the pollutants contributing to the reduction of TOC.

Polynomial, $y = 0.005t^2 + 0.13t + 0.1$ Equation 1

Exponential, $y = \exp(0.055t)$ Equation 2

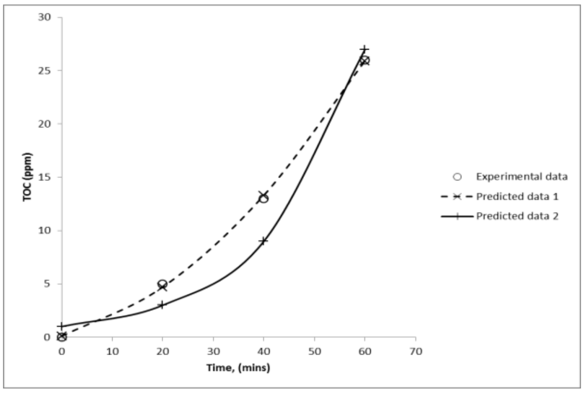

Figure 6: TOC reduction for different time

Data in Table 1 shows that there is a strong correlation between TSS and Turbidity, as illustrated in Figure 7 for greywater. TSS measures the amount of particles that are not dissolved in water, and these undissolved particles causes the water to loss its transparency, which is the reason for the strong correlation shown in Figure 7. Turbidity measures the degree of cloudiness or the level of transparency for the water. The higher reading of TSS, it will also mean higher turbididy. Similar correlation of TSS and turbididty has also been observed by Hannouche et al. (2012) and Daphne et al. (2011).

However, TSS does not correlate well with TOC, as shown in Figure 8. TOC refers to the total carbon exists in the organic compounds, which is not necessarily related to the undissolved particles, as illustrated by the weak correlation between TSS and TOC in Figure 8.

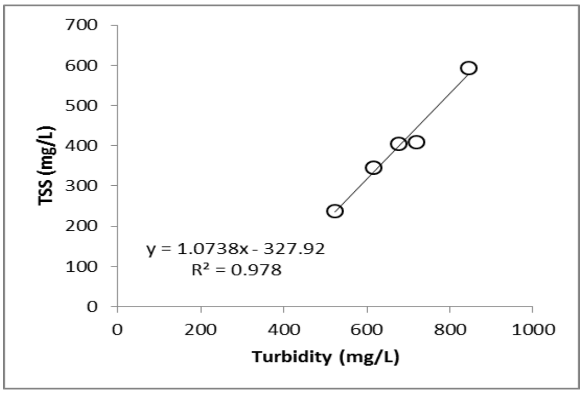

Figure 7: TSS versus Turbidity for greywater

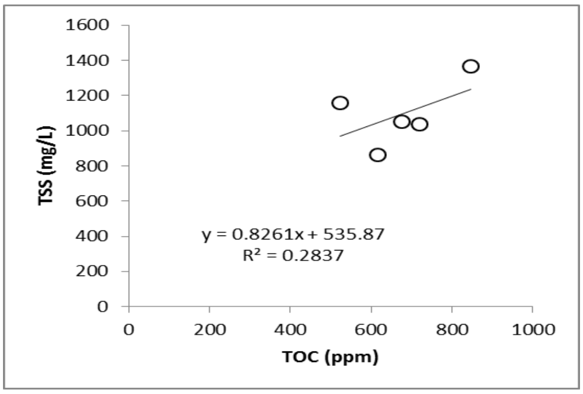

Figure 8: TSS versus TOC for greywater

4. CONCLUSION

This work studied on the potential of waste in reducing the total suspended solid (TSS), the turbidity and the total organic carbon (TOC) of the greywater and palm oil mill effluent. Three different wastes, coconut coir, sugarcan bagasse, and plastic wastes were used, and results were compared with those obtained using charcoal. The media were soaked in the wastewater for 30 minutes, and the maximum reduction of TSS, turbidity and TOC achieved was 38%, 60% and 42%, respectively. It was also found that TSS and turbidity showed a strong correlation, which indicates the proportionality of both parameters, but weak correlation found between TSS and TOC. Results obtained here indicate the potential application of waste material for improving the quality of greywater and palm oil mill.

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