BREWERY WASTEWATER TREATMENT WITH WATER HYACINTHS

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Abstract

Wastewater treatment technologies are essential, as water pollution is a major environmental concern. A natural treatment system is one of the most suitable treatment technologies, and it is a process of purifying contaminated water by growing aquatic plants that have the ability to absorb pollutants. This paper aims at investigating the removal efficiency (%) of brewery effluents (distillery effluents) using water hyacinth (*Eichhornia crassipes*). The treatment process in the present study was operated at the specified time duration, i.e., two hours, four hours, eight hours, one day, two days, four days and eight days. The physical and chemical characteristics, namely color, total dissolved solids (TDS), total suspended solids (TSS), conductivity, pH, biological oxygen demand (BOD_5), and chemical oxygen demand (COD) of the effluent samples before and after water hyacinth treatment were analyzed at the ISO TECH laboratory in Insein Township, Yangon. The physical and chemical parameters of the wastewater from the brewery are color (132 ± 2 TCU), total dissolved solids (1280 ± 4 mg/L), total suspended solids (633 ± 4.04 mg/L), pH (7.97 ± 0.19), conductivity (1806 ± 10.15µS/cm), biological oxygen demand (127 ± 8.62 mg/L), and chemical oxygen demand (196 ± 8.08 mg/L). The findings showed that color, TSS, and BOD_5 before treatment were higher than the guideline values for effluent. After eight days of treatment with natural plants, specifically water hyacinths, all analytical parameters were found to be well below the guidelines.

Keywords: wastewater treatment, water hyacinth, removal efficiency, physical and chemical characteristics, time duration.

Introduction

In recent years, the rapid growth of urbanization and the high standard of living have resulted in the rapid development of the industrial sector, leading to the generation of huge amounts of waste and wastewater (Ani Khare and Eugenia P.Lal, 2017). Large amounts of agricultural run-off and industrial effluents are increasing the pollution and contamination of freshwater resources and natural watercourses. Domestic waste, rubbish, and potentially toxic elements are also discharged into the environment by most people. Therefore, wastewater needs to be treated before it is released into the environment. This will reduce the contamination of the water resources around us. From the study of many research papers on water quality and its environment, many water bodies in Yangon are still suffering from sewage pollution. The most dangerous form of pollutants can be found in the wastewater that is discharged by many of the factories and industries in the industrial sector. Various factories, production companies, and manufacturing companies discharge different types of polluted wastewater. These wastewaters contain chemical pollutants and high concentrations of biodegradable organic compounds. These pollutants and organic compounds have an impact on water quality and make the water unsuitable for aquatic ecology (Zahra Mohebi, and Maryam Nazari 2021).

Water hyacinth, scientifically known as *Eichhornia crassipes*, is a perennial, free-floating aquatic plant that has been identified as capable of removing pollutants from industrial waste effluents (Jasmin Lad and Arti Pamnani, 2018). Water hyacinths, known for their capacity to absorb both organic and inorganic pollutants and their ease of management, play a crucial role in natural treatment systems. The utilization of water hyacinths in wastewater treatment has proven

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to be highly effective and economical (Ko Win and Aye Nyunt Kyi, 2020). These plants have demonstrated their efficiency in eliminating suspended solids, total dissolved solids,conductivity, organic matter, and various other dissolved pollutants from wastewater, resulting in the production of high-quality effluent. This paper explores the use of water hyacinth to remediate wastewater pollution from breweries.

Aim and Objectives

The aim of the present study is to evaluate the removal efficiencies (%) of physical and chemical characteristics for the treatment of distillery wastewater with water hyacinth. There are three objectives in this study, and they are as follows:

(1) to analyse physical characteristics, namely total dissolved solids (TDS), total suspended solids (TSS), colour and conductivity of the wastewater before and after treatment;
(2) to examine chemical characteristics such as pH, BOD_5 and COD of the effluent before and after treatment; and
(3) to calculate the removal efficiencies (%) of the physical and chemical characteristics of the effluent sample from the brewery followed by water hyacinth.

Materials and Method

The current research utilized water hyacinths to treat distillery wastewater. Two samples were collected for the study: water hyacinth (*Eichhornia crassipes*) and wastewater (distillery spent wash) obtained from a brewery. These samples were used as raw materials for experimental analysis.

Sample Collection

The plants used in this study were collected from upstream of the Aung Takhun Creek, which flows into Barla Creek and then into the Ngemoeyeik Creek, also known as Pazundaung Creek. After collecting the water hyacinth, rinse all samples thoroughly with tap water to remove impurities such as mud, microalgae, and insect larvae. Also, remove any unwanted parts of the plants, such as brown leaves and rotten roots. After cleaning, the sample plants were acclimatized for one week in tap water without any additional media or materials to allow them to adapt to their new environment (Mahesh W. and Jayaweera, 2008). Plants in good condition were then selected for experimental analysis.

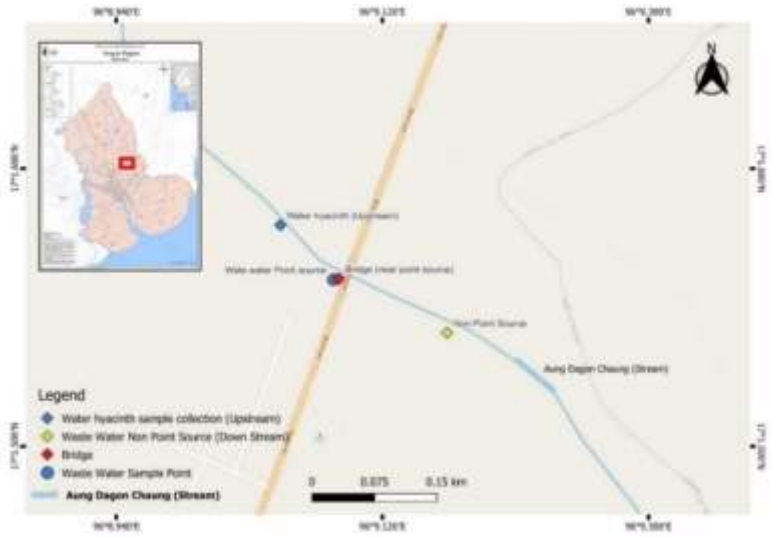

Figure 1 Location Map of Wastewater Sampling Site

Wastewater from the brewery is being discharged directly into Aung Takhun Creek and then flowing into Barla Creek. Wastewater sample were collected from the outlet of brewery directly and that is near No (3) Main Road at Pyinmabin Industrial Complex, Mingalardon Township, Yangon. Five 20-litre plastic bottles of wastewater samples were collected from the effluent (outlet) of the brewery's drainage system for the entire analysis.

Physico-chemical Analysis of Wastewater Sample

Wastewater sample before and after treatment were analysed for pH, colour, conductivity, total dissolved solid (TDS), total suspended solid (TSS), 5-day biological oxygen demand (BOD_5), and chemical oxygen demand (COD). For the analysis of wastewater sample before treatment, pH, conductivity and TDS of wastewater discharged from the brewery were measured on site using eXact Master Kit with pH & ORP, Part No. 486303. In addition, the pH, conductivity, and TDS of treated wastewater were measured in the laboratory at the Department of Environment and Water Studies, University of Yangon, after every treatment. Furthermore, after each treatment, the treated wastewater was sent to the ISO TECH laboratory in Insein Township at Yangon to test other parameters. The examination of wastewater characteristics before and after treatment, specifically BOD_5 and COD, was conducted following the UAS Standard Method 22nd Edition. The colour of water samples was tested using the Lovibond Spectro Direct Method No. 203. TSS was determined using the DR 3900 Spectrophotometer (HACH) with the Photometric Method.

Wastewater Treatment Process

Fifteen litres of collected wastewater were filtered and poured into a plastic bucket of 35 cm in diameter and 25 cm deep. Water hyacinth plants of the same size, with a total weight of about 1 kg, were evenly distributed in the wastewater sample contained in the plastic bucket. After the specified hours, four litres of treated wastewater were taken from each bucket and then sent to the laboratory. In this study, the duration of the experiments was set at two hours, four hours, eight hours, one day, two days, four days, and eight days.

Determination of Removal Efficiency (%)

After the analytical results had been obtained, removal efficiencies (%) of the characteristics of wastewater were calculated by the following equation (Rajnikant Prasad et al., 2021).

$$\text{Removal efficiency (\%)} = \frac{\text{Concentration before treatment} - \text{Concentration after treatment}}{\text{Concentration before treatment}} * 100\%$$

Results and Discussions

The ISO TECH laboratory in Insein Township, Yangon, analysed the TSS, BOD_5, and COD water quality characteristics of distillery wastewater before and after treatment, following the 'Standard Methods for the Examination of Water and Wastewater'. Table 1 compares the measured water quality parameters with the wastewater quality guidelines (Myanmar Emission Guidelines, 2015). Table 1 displays the minimum, maximum, and average values of the untreated wastewater characteristics. The characteristics of the treated wastewater are presented in Table 2. Table 3 shows the percentage of removal efficiency of water hyacinth.

Table 1. Characteristics of Untreated Wastewater

Sr No	Parameters	Unit	Min-Max	Average ± SD	Myanmar Emission Guidelines (2015)
1	Colour	TCU	129 - 135	132 ± 2	15
2	Total dissolved solids (TDS)	mg/L	1276 - 1284	1280 ± 4	1500
3	Total suspended solids (TSS)	mg/L	629 - 637	633 ± 4.04	50
4	pH	-	7.78 - 8.16	7.97 ± 0.19	6–9
5	Conductivity	µS/cm	1795 - 1815	1806 ± 10.15	2000
6	Biological oxygen demand (BOD_5)	mg/L	119 - 136	127 ± 8.62	50
7	Chemical oxygen demand (COD)	mg/L	189 - 205	196 ± 8.08	250

Table 2 shows the variations in process parameters (colour, TDS, TSS, BOD_5, and COD) in the wastewater after treatment during the study period.

Table 2. Characteristics of Treated Wastewater

Parameters	After Treatment						
	2 hours	**4 hours**	**8 hours**	**1 day**	**2 days**	**4 days**	**8 days**
Colour	121	98	75	49	25	17	15
Total dissolved solids (TDS)	1165	1150	1100	907	755	615	598
Total suspended solids (TSS)	563	490	411	253	137	49	45
pH	7.82	7.75	7.62	7.45	7.29	7.01	7.00
Conductivity	1631	1615	1551	1160	1025	867	421
Biological oxygen demand (BOD_5)	109	91	78	58	43	13	10
Chemical oxygen demand (COD)	180	164	131	108	82	33	28

The removal efficiencies of water hyacinth in the treatment of brewery effluent and the corresponding time periods are shown in Table 3.

Table 3. Removal Efficiency % of Water Hyacinth

	Removal Efficiency %				
Time Duration	**Colour**	**TDS**	**TSS**	**BOD_5**	**COD**
2 hours	12.88	8.98	11.06	14.17	8.16
4 hours	25.76	10.96	22.59	28.35	16.33
8 hours	43.18	14.06	35.07	38.58	33.16
1 day	62.88	29.14	60.03	54.33	44.90
2 days	81.06	41.02	78.36	66.14	58.16
4 days	89.39	51.95	92.26	89.76	83.16
8 days	91.67	55.23	94.00	92.13	85.71

Figure 2 shows the colour removal efficiencies (%) in the treatment of distillery wastewater with water hyacinth. From the graph, it can be seen that the minimum removal efficiency is 12.88 % after two hours of treatment, and the maximum removal efficiency is

91.67% over the eight-day treatment period. After four hours, 25.76% was removed, and after eight hours, 43.18% was removed. In addition, it was found that the removal efficiency was 62.88% after one day of treatment and 81.06% after two days of treatment.

Figure 3 shows the efficiency (%) of total dissolved solids (TDS) removal when treating distillery waste with water hyacinth. The results indicate that after two hours of treatment, the minimum removal efficiency is 8.98%, while the maximum removal efficiency is 55.23% after eight days of treatment. After four hours of treatment, the removal efficiency is 10.16%, and after eight hours, it is 14.106%. Additionally, the removal efficiency is 29.14% after one day and 42.10% after two days.

Figure 4 shows the percentage of total suspended solids (TSS) removed during the treatment of distillery wastewater using water hyacinth. The results indicate that the minimum TSS removal efficiency is 11.06% after two hours of treatment, while the maximum TSS removal efficiency is 94.00% after eight days of treatment. The removal efficiency for four hours of treatment is 22.59%, and for eight hours of treatment, it is 35.07%. Additionally, TSS removal is 60.03% after one day and 78.36% after two days.

In this study, the minimum removal efficiency of water hyacinth for 5-day biological oxygen demand (BOD_5) was observed to be 14.17% after two hours of treatment. The removal efficiency increased to 28.35% after four hours, 38.58% after eight hours, 54.33% after one day, and 66.4% after two days. At the end of the four-day treatment period, 89.76% of the BOD_5 was removed from the untreated distillery wastewater. After eight-day treatment, maximum removal efficiency was 92.13%. Figure 5 shows the recorded results.

During the two-hour treatment period, the COD removal efficiency was found to be a minimum of 8.16%. The removal efficiency increased to 16.33% after four hours, 33.16% after eight hours, 44.90% after one day, 58.16% after two days, 83.16% after four days and reached a maximum of 85.71% after eight-day treatment. The analytical results are presented in Figure 6.

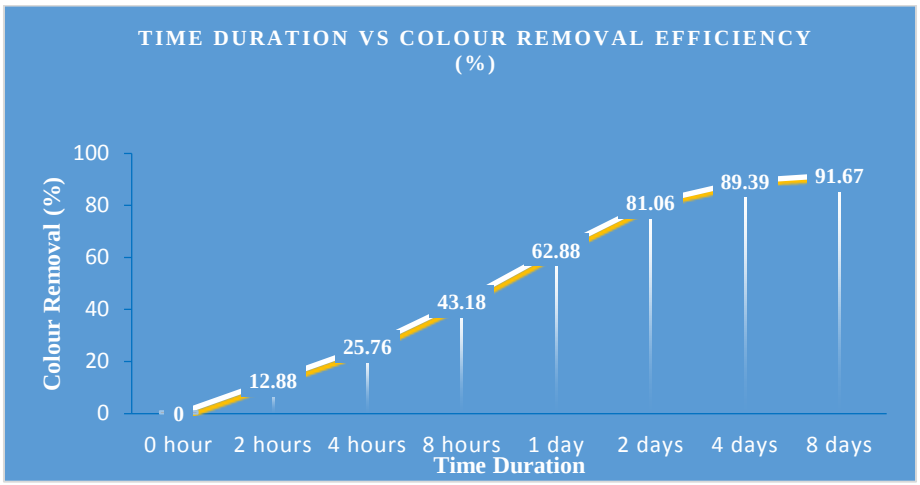

Figure 2. Colour Removal Efficiency (%) of Water Hyacinth

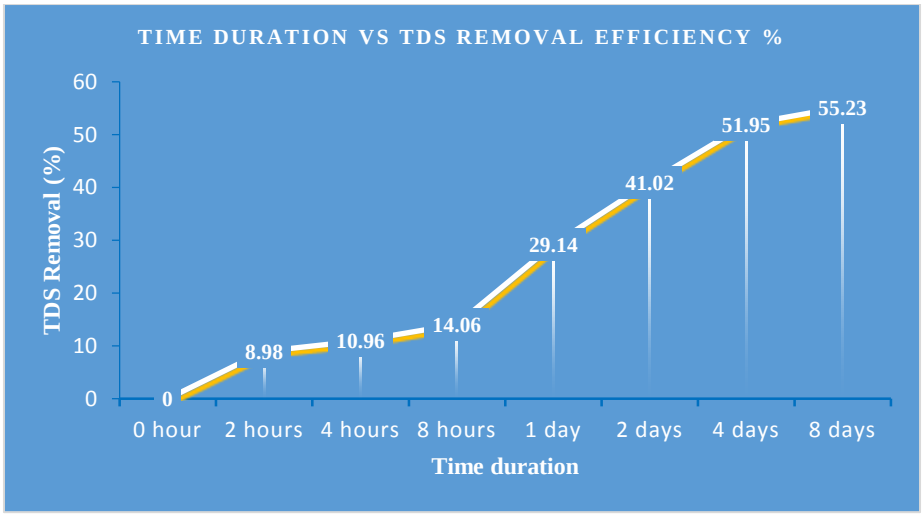

Figure 3. Removal Efficiency (%) of Water hyacinth for Total Dissolved Solids (TDS)

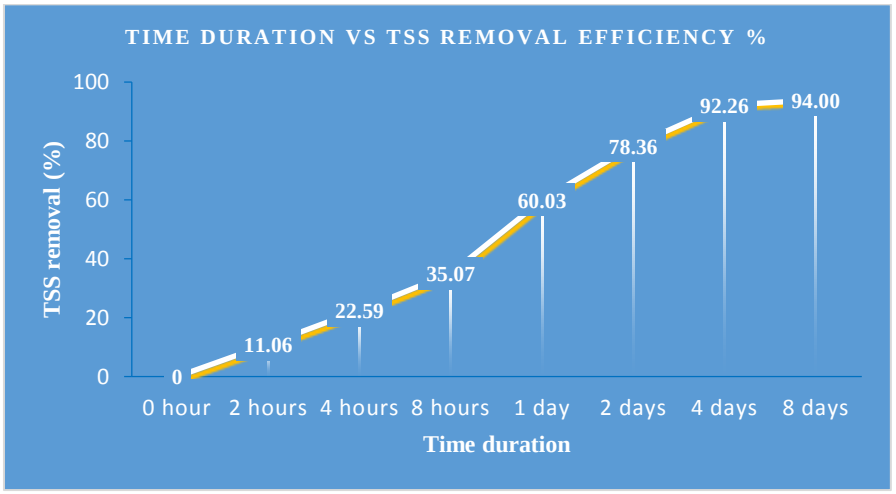

Figure 4. Removal Efficiency (%) of Water Hyacinth for Total Suspended Solids (TSS)

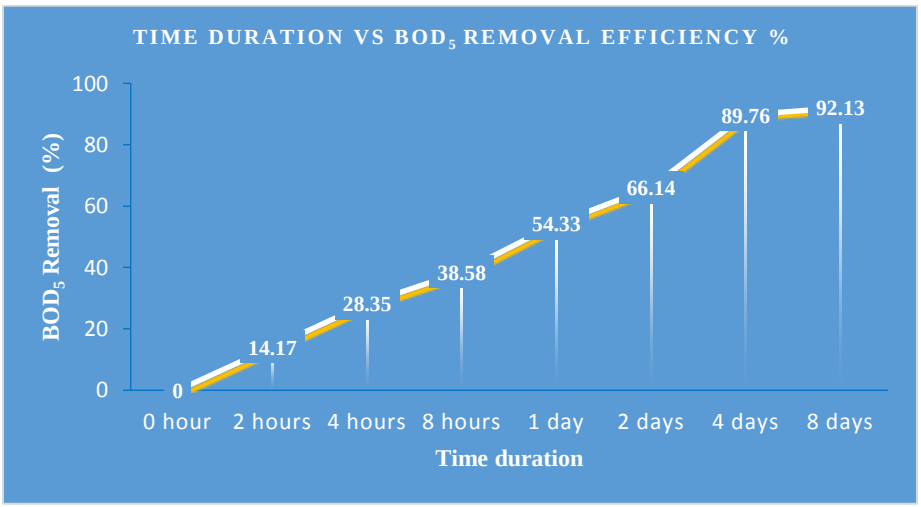

Figure 5. Removal Efficiency (%) of Water Hyacinth for Biological Oxygen Demand (BOD_5)

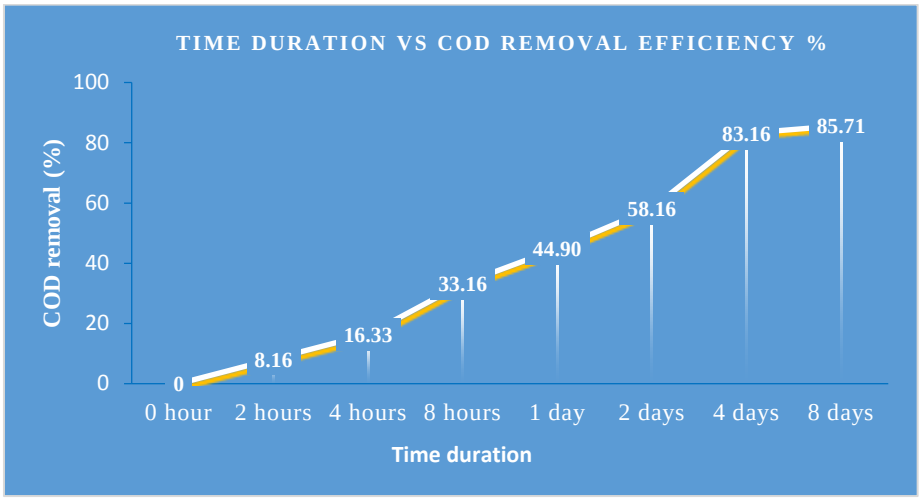

Figure 6. Removal Efficiency (%) of Water Hyacinth for Chemical Oxygen Demand (COD)

All the graphs in Figure 2 to Figure 6 were obtained using the analytical results, it can be seen clearly that the percentage removal of five parameters: colour, TDS, TSS, BOD_5, and COD are increasing with the increasing of time duration for the treatment. At the end of the eight days, physical and chemical parameters of treated wastewater are well below the guideline values limited by Myanmar Emission Guidelines (2015).

Conclusion

The longer the time duration, the higher the removal of color, TDS, TSS, BOD_5, and COD from the experimental results. Additionally, the removal percentage of TSS is superior to that of TDS, and the removal efficiency of 5-day biological oxygen demand (BOD_5) is greater than that of chemical oxygen demand (COD). For the specified experimental durations of four days and eight days, the rate of removal is lower than in other experimental periods. After eight days of treatment, all parameters of treated wastewater are well below the Myanmar National Environmental Quality (Emission) Guidelines (2015). This study concludes that the water hyacinth system is effective for treating brewery wastewater, particularly in Myanmar due to its tropical and subtropical climate, making the water hyacinth plant highly suitable for natural wastewater treatment technology.

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