Waste Water Purification Using Locally Available Aquatic Plants

R.M.S.B.S Ranatunga[1] and K.M.L.A Udamulla[2]

Department of Civil Engineering
Northshore College of Business and Technology
Colombo 15, SRI LANKA

Dept. of Civil Engineering, The Open University of Sri Lanka
Nawala, Nugegoda
SRI LANKA

E-mail: lakshika0807@hotmail.com

Abstract: *The primary objective of this study was to evaluate the performance of two different* aquatic macrophyte *for treatment of municipal waste water collected from Colombo 15. A physical model of a treatment plant was constructed and was operated for four experimental runs. Every experimental run consisted of a fourteen day period. Locally available macrophyte species (Water Hyacinth and Duckweed) were selected for testing. To evaluate the each macrophyte, BOD, COD, Plant growth monitoring, Bio-mass production, PH values and Temperature were monitored. The average reduction values for each parameter, using Water Hyacinth, was 57.64% for BOD, 55.85% for COD,34% reduction of BOD at a Temperature of 25-35 C0,41% reduction of BOD at a PH value of 6.5-8.5.For Duckweed, the average removal efficiency for the selected parameters were 51.53% for BOD, 31.53% for COD, 20% reduction of BOD at a Temperature of 25-35 °C, 23% reduction of BOD at a PH value of 6.5-8.5.A significant growth of plant biomass was measured within the first two weeks of the first run. It was also observed that performance of macrophytes (Duckweed and Water Hyacinth) is influenced by variations in pH and temperature. A PH level of 6.5-8.5 and temperature of 25-35 °C is most favourable for treatment of waste water by macrophytes. When considering all the water quality parameters which were tested Water Hyacinth has the better and more superior waste water purification efficiency when compared to Duckweed.*

Keywords: *Waste water purification, water quality parameters, Water Hyacinth, Duckweed.*

1. INTRODUCTION

The growing population and an increase of industrialization and agriculture and agricultural production in numerous countries such as Sri Lanka require more and more water of adequate quality. In many regions there is a lack of surface water and serve water contamination is to be found (Masbough et al,2005). Therefore, it is of high priority to take into consideration all the proved water techniques that could help reduce the existing disaster of water pollution.

Wastewater is a term applied to any type of water that has been utilized in some capacity that negatively impacts the quality of the water. Common examples of wastewater include water that is discharged from households, office and retail buildings, and manufacturing plants. Wastewater may also refer to any water that is utilized in an agricultural facility and is no longer considered fit for human consumption. The most common example of wastewater is liquid sewage. Discharged from homes and businesses alike, sewage usually contains a mixture of human waste, food remnants, water used in washing machines, and any other items that may have found their way into the sewage system. (Wallace and Knight, 2006). Many municipalities operate wastewater treatment plants that help to purify the sewage and recycle the water for other uses. However, the nature of the contaminants may require additional measures before the water is suitable for use once more. Along with the use of chemicals to treat wastewater, the use of environmentally friendly methods is sometimes employed. Soap and similar agents with relative ease, allowing the water to be reclaimed. However, many forms of wastewater today require heavy chemical treatments in order to remove harmful agents from the water and make it safe for further use (Cooper et al,1996) Therefore, in this research it is examined the usage of two locally available aquatic plants (*Water Hyacinth, Duckweed)* are effective in waste water purification process.

2. METHODOLOGY

The methodology is as follows:

(i) Selection of plants : Out of the aquatic plants which can be grown in Sri Lanka and has the ability to purify water Duckweed and Water Hyacinth were selected according to certain key aspects such as applicability, design considerations and health and maintenance.

(ii). Construction of the treatment system: Instead of building a full wetland an alternative method was used. Two 50cm diameter basins, two 45cm diameter basins and two 36cm diameter basins were used in the system. The basin which has the highest diameter was placed on the top of the wetland system and then the 45cm diameter basin and the 36cm diameter barrel will be placed at the bottom accordingly. In order to help gravity to take from the elevated basins to the lower basin, basins were connected to pipe horses. These basins have a capacity of 36 litters and the experiment was conducted in a continuous circular flow system. Figure 1 shows the mechanism of the system.

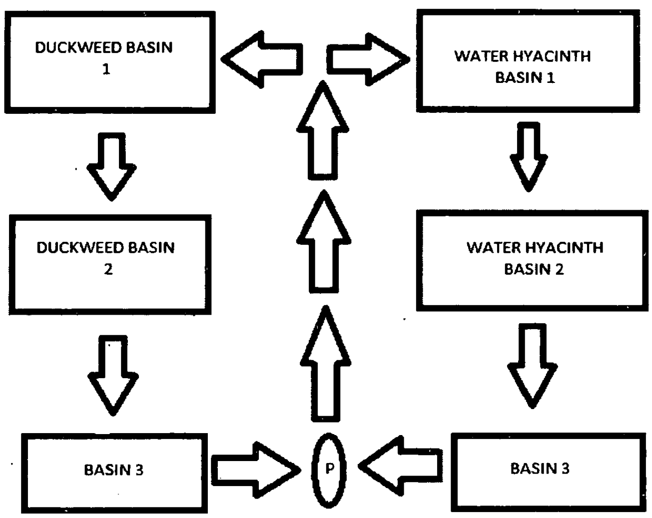


Figure 1 Mechanism of the wetland system

As shown in the figure 2 selected waste water sample from Colombo 15 municipal area was filled into the Duckweed pond and Water Hyacinth pond, In order to maintain the circular motion two water pumps were introduced and the water form basin 3 of the Duckweed system and Water Hyacinth will be connected into two different pumps separately to keep the water from getting mixed. In order to minimize the high suction pressure of the pumps a syringe was installed into the pipe which will reduce the effect of the high suction pressure.

Figure 2 Treatment system

(iii). Water quality parameters

Water quality parameters will be tested within a period of 4 months. This two month period will be divided into 4 runs where a single run consists of 28 days weeks. The water quality parameters such as Biomass production, COD (Chemical Oxygen Demand), BOD (Biological Oxygen Demand), PH value, Temperature were tested at the end of each run.

3. RESULTS AND DISCUSSION

Initial parameters of the municipal waste water sample are given in table 1.

Table 1 Initial parameters of the municipal waste water

Parameters	Unit	Value
Biological Oxygen Demand	mg/l	130
Chemical Oxygen Demand	mg/l	222
Temperature	°C	26
PH	Nil	8.74

3.1. Biological Oxygen Demand

To test the BOD levels in the built wetland, water samples were collected from each basin and the samples were taken to a laboratory to test where the samples were tested in an incubated condition of 250°C. Table 2 and 3 provides the BOD values of Water Hyacinth pond and Duckweed pond separately.

Table 2 Collected BOD values of Water Hyacinth

Time (Days)	BOD (mg/l)			
	Run 1	Run 2	Run 3	Run 4
0	130	68	58	57
14	80	68	58	56
28	70	62	57	55

Table 3 Collected BOD values of the Duckweed pond

Time	BOD (mg/l)			
	Run 1	Run 2	Run 3	Run 4
0	130	76	71	65
14	85	73	68	64
28	81	73	65	63

Figure 3 shows the comparison of BOD of Water Hyacinth and Duckweed.

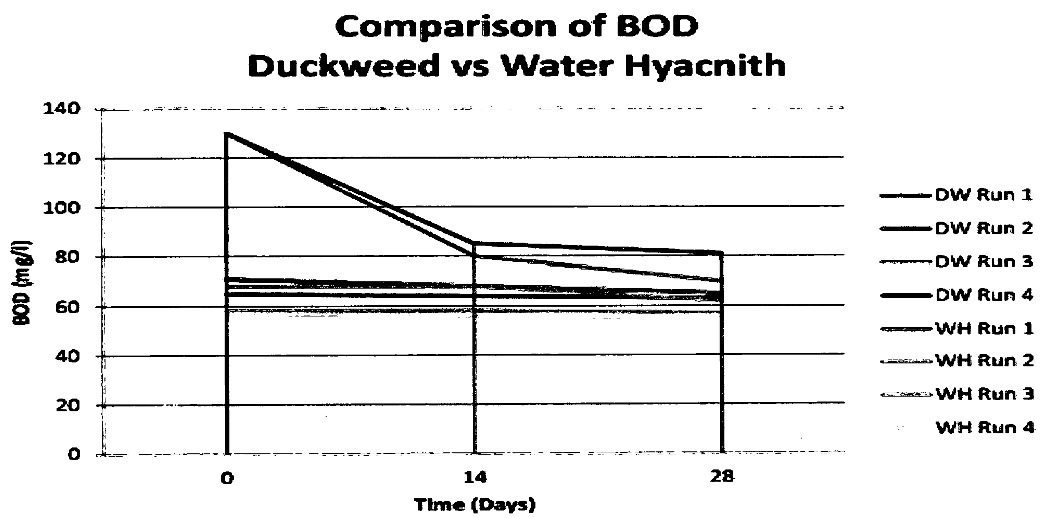


Figure 3 Comparison of BOD measurements

The results showed that Water Hyacinth showed the maximum removal (130-55 mg/l) of BOD compared to duckweed (130-63 mg/l). It was observed that removal of BOD occurs mainly in the first ten to fourteen days of the 1st run; after that the removal it is at a slower rate which means that the breaking of organic matter is drastically reduced which is a critical observation for future studies and improvements.

3.2. Chemical Oxygen Demand

COD is the amount of oxygen necessary to oxidize the organic compound in the water completely to CO_2, H_2O and NH_3. COD is measured through oxidation with potassium dichromate ($K_2Cr_2O_7$) in the presence of sulphuric acid and silver. Table 4 and 5 represents the COD values of Water Hyacinth pond and Duckweed pond.

Table 4 Collected COD values of Water Hyacinth pond

Time (Days)	COD (mg/l)			
	Run 1	Run 2	Run 3	Run 4
0	222	124	114	100
14	172	128	108	98
28	122	116	106	98

Table 5 Collected COD values of Duckweed pond

Time (Days)	COD (mg/l)			
	Run 1	Run 2	Run 3	Run 4
0	222	180	167	156
14	205	177	164	155
28	185	170	157	152

Figure 4 shows the comparison of COD of the water of Duckweed pond vs. Water Hyacinth pond measurements.

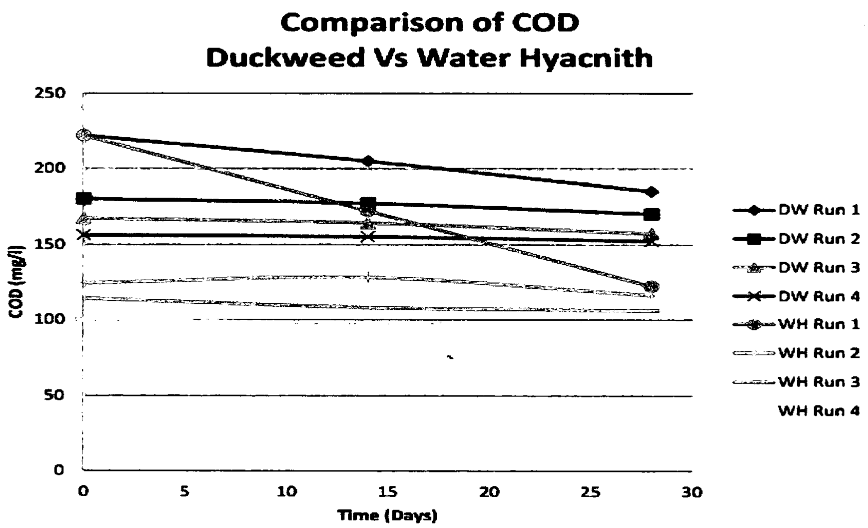


Figure 4 Comparison of COD measurements

Results clearly show that the removal efficiencies of COD is somewhat similar to the BOD measurements within the first 14 days of the experiment, and when comparing the COD removal efficiencies of the two plants it is significantly clear that Water Hyacinth has the better removal efficiency in terms of COD which is 222 mg/l to 98 mg/l.

3.3. Temperature

Table 6 and figure 5 show the temperature and the BOD removal efficiencies of Duckweed and Water Hyacinth.

Table 6 Temperature and BOD removal efficiencies

Temperature	BOD Removal efficiency %	
	Duckweed	Water Hyacinth
22	17	27
25	15	33
35	25	35

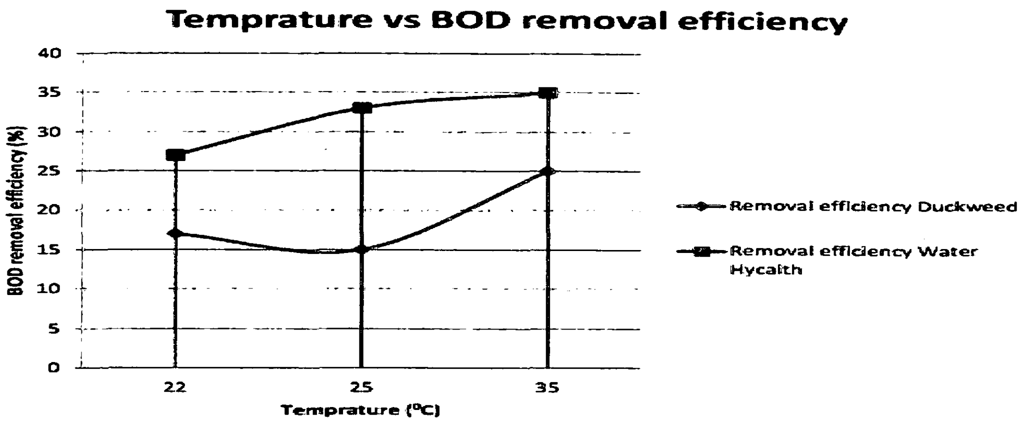


Figure 5 Temperature vs. BOD removal efficiency

During the experiments it was observed that macrophytes (Duckweed and Water Hyacinth) are sensitive to temperature. Therefore, according to the experiment conducted it is quite clear that a temperature between 25-35°C is suitable for treatment of waste-water by macrophytes, as the growth rate was optimum at this temperature and BOD removal efficiency is high too. When comparing the two plants it is clearly visible that Water Hyacinths efficiency is higher at the ideal temperature when compared to Duckweed.

3.4. PH levels

Table 7 and Figure 6 show the PH levels and BOD removal efficiencies.

Table 7 PH levels and BOD removal efficiencies

PH	BOD Removal efficiency %	
	Duckweed	Water Hyacinth
5	0	0
6.5	22	42
8.5	24	40
10	3	4

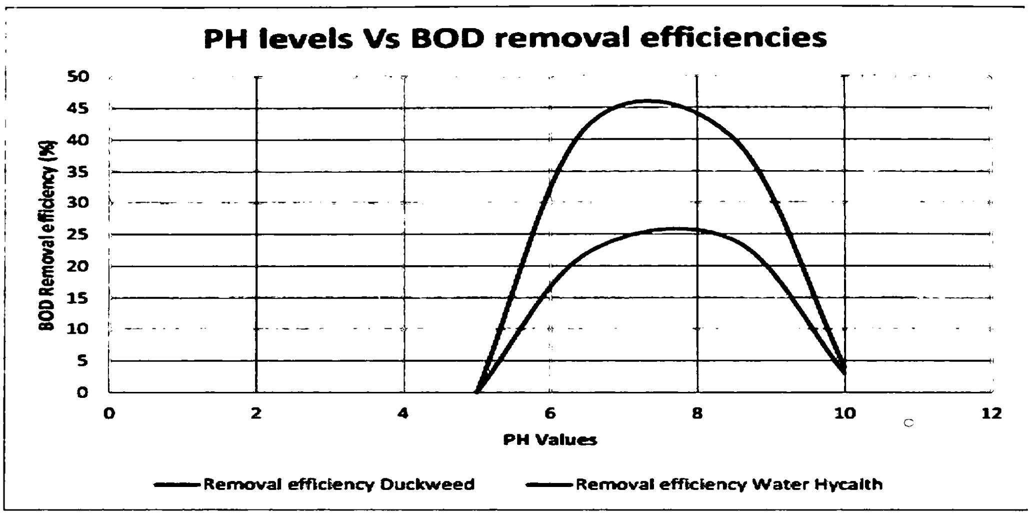
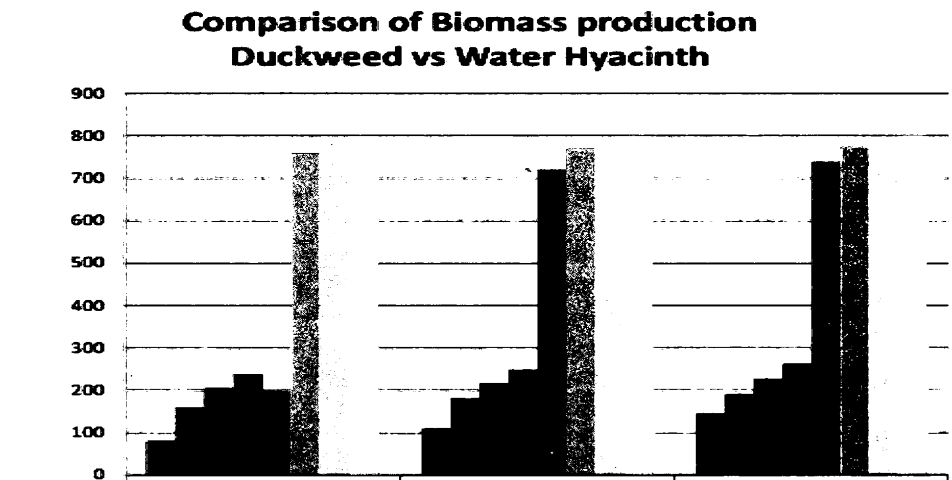


Figure 6 PH levels vs. BOD removal efficiencies

In order to monitor the effect of the variation of PH on performance of Duckweed and Water Hyacnith the experiment was conducted at temperature of 25°C at different levels of PH. According to the test results and the graph 6 it is clear that at a PH level below 5, BOD removal is almost zero. On the other hand when the PH level gradually increases the removal efficiency rate increases till the PH value reaches 7.5, and thereafter the removal efficiency decreases again. Therefore, according to the test results it is quite clear that the PH value range of 6-9 is most suitable for the performance of macrophytes and it is clear that the removal efficiency of Water Hyacinth is better than Duckweed at the optimum PH level.

3.5. Biomass Production

In every two weeks 'time initial weight of biomass were calculated in water hyacinth and duckweed. Figure 7 show the comparison of biomass production of Water Hyacinth and Duckweed.



	0	14	28
DW Run 1	[redacted]	[redacted]	145.14
DW Run 2	160.56	182.08	190.67
DW Run 3	205.44	217.23	227.16
DW Run 4	238.77	249.54	262.33
WH Run 1	[redacted]	[redacted]	740.44
WH Run 2	760.25	770.06	775
WH Run 3	780.12	783.1	789.08
WH Run 4	795.98	796.09	800.1

Figure 7 Comparison of Biomass production

Based on the above graphs it is clear that both Duckweed and Water hyacinth has a significant biomass growth within the first 14 days (Highlighted values) and both the duckweed and water hyacinth will act most effectively within the first two weeks of the experiment. When comparing the two plants even though it has the same growth level Water hyacinth will reach the higher biomass within the 14 day period which wills catalyst the water purification more than the duckweed pond.

4. CONCLUSIONS

The average reduction values for each parameter, using Water Hyacinth, was 57.64% for BOD, 55.85% for COD,34% reduction of BOD at a Temperature of 25-35 C0,41% reduction of BOD at a PH value of 6.5-8.5.For Duckweed, the average removal efficiency for the selected parameters were 51.53% for BOD, 31.53% for COD, 20% reduction of BOD at a Temperature of 25-35 °C, 23% reduction of BOD at a PH value of 6.5-8.5.A significant growth of plant biomass was measured within the first two weeks of the first run. It was also observed that performance of saprophytes (Duckweed and Water Hyacinth) is influenced by variations in pH and temperature. A PH level of 6.5-8.5 and temperature of 25-35 °C is most favourable for treatment of waste water by saprophytes. When considering all the water quality parameters which were tested Water Hyacinth has the better and more superior waste water purification efficiency when compared to Duckweed.

.

5. REFERENCES

Brix, H. Functions of saprophytes in constructed wetlands, 1994. Water Sci. Tech. 29, 71-78

Cooper, P.F., Job, G.D., Green, M.B. and Shutes, R.B.E. 1996. Reed beds and constructed wetlands for wastewater treatment. WRc Swindon. 184 pp.

Masbough, A.; Frankowski, K.; Hall, K.J.; Duff, S.J.B. 2005. The effectiveness of constructed wetland for treatment of wood waste leachate,. Ecol. Eng. 25, 552-566.

Wallace, S.D.; Knight, R.L. Small Scale Constructed Wetland Treatment Systems. Feasibility, Design Criteria, and O&M Requirements, 2006. Water Environ. Res. Foundation: Alexandria, VA, USA.