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PHYTOREMEDIATION: TREATING EUTHROPHIC LAKE AT KotaSAS LAKESIDE, KUANTAN BY AQUATIC MACROPHYTES

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Abstract. This investigation was embraced ex-situ to investigate the capability of the submerged plants' water hyacinth (Eichornia crassipes) and water lettuce (Pistia stratiotes L.) as phytoremediation aquatic macrophytes for nutrients removal from a eutrophic lake situated at KotaSAS Lakeside surrounded by residential area as the risk of algae bloom can be avoided. The present of mankind activities such as sewage runoff and agricultural towards water bodies, the eutrophication process being speed up. The capability of these plants to evacuate certain parameters not just supplements while additionally including BOD5, COD, TSS, Turbidity, and heavy metals. The technique for investigation of lake water was alluded by Standard Method for Examination of Water and Wastewater. Water lettuce displayed extraordinary nitrate removal effectiveness up to 94% however this plant species shrivelled from week 2 of the examination because of an absence of nitrate supply and caused an expansion in phosphorus concentration. Then, water hyacinth indicates relentless evacuation productivity with a normal of 82% for nitrate and phosphorus. Other than that, water hyacinth indicates 88% and 72% of TSS and turbidity expulsion effectiveness which can improve the clarity of lake water. With this accomplishment gained in phytoremediation innovation utilizing water hyacinth, it is of most significance for this innovation to be executed in bigger scales in the future.

1. Introduction

Eutrophication can be defined as a process of the aggressive growth of algae on the surface of water, as caused by excessive richness nutrients through surface runoffs that carry down by fertilized agricultural areas, sewage form cites, and industrial waste [9]. All the water bodies will undergo eutrophication naturally, but it is slow. Cultural eutrophication is the involvement of mankind activities such as urbanization, industrialization and intensifying agricultural production which

discharge a lot of nutrients mainly in nitrogen and phosphorus until it exceeds the capacity of the water body and trigger aquatic plants and algae bloom in the surface of water. Once these happened, the aquatic ecosystem in the water body will slowly malfunction because the transparency of surface water is affected.

In order to treat the eutrophic lakes, phytoremediation is used because it regarded as one of the most cost-effective, sustainable, and affordable technologies. Phytoremediation is a plant-based system which directly used of green plant in-situ to reduce pollutants in the lakes. This method is ecologically friendly and solar dependent clean-up technology [6]. Some of the floating macrophytes shows its potential in removing excess nutrient in lakes. Throughout a journal study, Pistia stratiotes L. is used to treat sewage. The results show that this plant had an efficiency of removing 83% nitrate nitrogen, 84.8% ammonia nitrogen and 81.6% Phosphate from sewage [12]. The given study area in Kotasas Lakeside, Kuantan Pahang need to carry out phytoremediation in treating the excess nutrient in that area. There are two species plant used to carry phytoremediation for this lakeside which are *Pistia Stratiotes* (Water Lettuce) and *Eichhornia Crassipes* (Water Hyacinth). This lakeside will be construct as a recreational park in the future. Through this study, the most suitable plant species will be chosen to render the eutrophication process, and this will bring full advantages to the nearby residents because the risk of algae bloom can be avoided.

Every water bodies in the world will undergo eutrophication proses naturally. But, with the present of mankind activities such as agricultural and sewage runoff to the water bodies, the eutrophication proses being speed up and this had caused a lot of environmental issues to the world. The Star Online had report that excess nitrogen runoff had cause problem such as fish kills and global warming. In the report, humans had produced 190 million tone of usable nitrogen which is much greater than 112 million tone created by natural processes. This excessive nitrogen had caused eutrophication, and this led to oxygen depletion in water bodies. Therefore, the fish cannot survive in these living conditions and the ecosystem is being interrupt [15].

In addition, algae bloom with toxin also created a lot of troubles to human being. In Malaysia, there are many cases involve with harmful algae bloom which affect the human health. Algae bloom is not only causing adverse effects to the natural surrounding environments, but also caused human food poisoning due to accumulation of algae toxin in the seafood product. The event had warned the relevant authorities on the needs of better monitoring the safety of seafood product which is free from algae toxin [8].

Phytoremediation is a plant-based technology that mostly used to clean up contaminated environment. This technology requires high area input and need expertise labour and energy. Plant is used to clean up the polluted environment [1]. In more recent years, it is found that the industrial waste of chemical damage the environment and people start research on this technology in remediation of the industrial damage [3]. The research and application of phytoremediation technology had carried on over the last 15 years. The reason of choosing aquatic plants as a medium of removing contaminants not only because of its efficiency, it is also a low-cost treatment method [16]. The excessive biomass of plant will be harvested and used for other purpose such as food for livestock [11]. The high heavy metal concentration uptake by plant had found by many researchers that it had no negative or toxic effect in plant growth. Therefore, the used of plants in removing heavy metal is a very eco-friendly approach [1]. Pistia stratiotes L. (water lettuce) is a free-floating aquatic plant. The leaves of this plants are in rosette which forming singly or connected to the others by short stolon. Leaves of the plant are in pale green and mostly in 10 to 20 cm long. The roots of the plants are long, feathery and bearing long root caps [5]. Echhornia crassipies (water hyacinth) can raise up from the surface of water about 1-meter height due to its thick, glossy and ovate leaves. The common length of its leaves is about 10 to 20 cm long. The roots of water hyacinth are in purple black colour. In the fast-growing

plants ranking, water hyacinth had its own place. Water hyacinth is not suitable in the water which contain high salinity [10]. Specifically, the main objective can be stated that to evaluate the potential of the plants in removing the excess nutrients and purification of lake at KotaSAS Lakeside and to determine the physical and chemical and biological characteristics in the lake as well as the capability of selected plant species in remediating lake.

2. Experimental

The collection of lake water sample, two points of the lake are selected. The procedure of collecting water sample is following the standard manual produced by the Environment Laboratory of University Malaysia Pahang. About 200 litres of lake water sample were collect by using plastic bottle. The preservation of lake water is a must in order to ensure the quality of data obtained from the testing can represent the actual data for the parameter at the recent time. The plants were collected from different areas in a sufficient amount. Water hyacinths were collected from the riverside which nearby Toyota, Jalan Sungai Isap 3 and water lettuces were obtained from a small lake located in front of SMK Bukit Rangin. All the plants were subjected for adaption process in untreated tap water. The plants could adapt for 2-week period in order to ensure a well-balanced condition for them to grow.

Before conducting the experiment, it is very important to make sure the design of the tank has been designed and measured properly. In order to analyze the physical characteristic of lake water, transparency tank is used as control sample and distribution tank. One of the tanks is used as control while the other two is for water lettuce and water hyacinth plant species. The two-point sources of water samples were mix well and distributed to three tanks with equal amount of litre. After that, the two species of plant are cultivated into their tank respectively. The water quality was determined every week until week 7. The control tank was leave with water sample and no species cultivated in this tank. All of the tank was leave in place with partial sunlight with roof cover.

For each sampling period, two samples from the treatment tank will be collected for further evaluation. These water samples will then be analysed based on the following parameters: biochemical oxygen demand (BOD5), chemical oxygen demand (COD), total suspended solid (TSS), pH, concentration of heavy metals such as zinc (Zn), iron (Fe) and also concentration of nutrients such as nitrogen and phosphate concentration. For heavy metal and nutrients content analysis, atomic absorption spectrophotometer (ASS) is used.

Analyses were done on the fore mentioned parameters before and after phytoremediation treatment weekly. This is important to determine the effectiveness of phytoremediation technology to remove excessive nutrients content from the contaminated lake water samples. All the analysis is carried out at Environmental Engineering Laboratory of Faculty of Civil Engineering and Earth Resources, UMP. The equation used in determining the removal efficiency is stated below.

$$Removal\ efficiency\ (\%) = \frac{Influent\ \left(\frac{mg}{L}\right) - Effluent\ (\frac{mg}{L})}{Influent\ (\frac{mg}{L})} \quad (1)$$
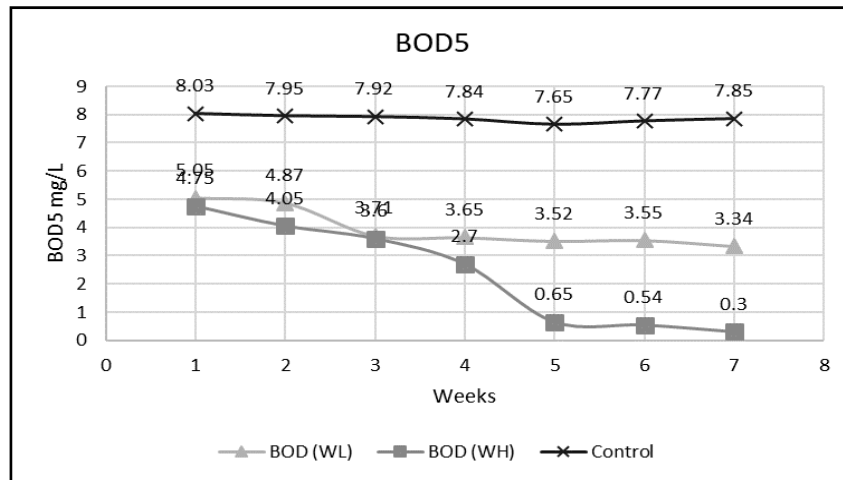
3. Results and Discussion

Figure 1. BOD_5 concentration between two types of plants for 7 weeks graph

BOD_5 is an essential water quality parameter for this study because it can provide an index to evaluate the water quality whether it is contaminated by excess algae growth. The higher the BOD indicated that the greater the organic matter contain inside a water bodies and this cause the DO of a water bodies consume by microorganism exceed the DO supply by aquatic plants. When this occur, unfavourable condition such as eutrophication will occur. BOD_5 is the measurement of the BOD value for five day and it is the most widely used method to evaluate pollution level of a water bodies [2].

The figure 1 above illustrated the BOD decreasing in lake water that obtained at KotaSAS Lakeside by using water lettuce and water hyacinth species. Those two samples are used to treat the lake water for seven week and the result are plotted in figure 1 Both plant species show that there are gradually decrease in BOD concentration for the first 3 week while slightly decreasing at the rest of the week. Besides that, the average result for both species also used to compare with the control group in order to determine the removal efficiency of both plants

. Based on the study water hyacinth shows its BOD removal efficiency far higher than water lettuce which is 70% compare to 50% respectively. It is not surprisingly because according to Rezania's research, water hyacinth had high BOD removal efficiency. The high reduction of BOD concentration by water hyacinth is because this plant species can provide a support medium for microbial degradation to take place in water bodies [13]. Furthermore, other researcher also prove that the presence of phytoremediation provide energy for microbial metabolism so that the BOD concentration can be highly reduced [14]. Therefore, water hyacinth had higher ability in removing BOD concentration than water lettuce
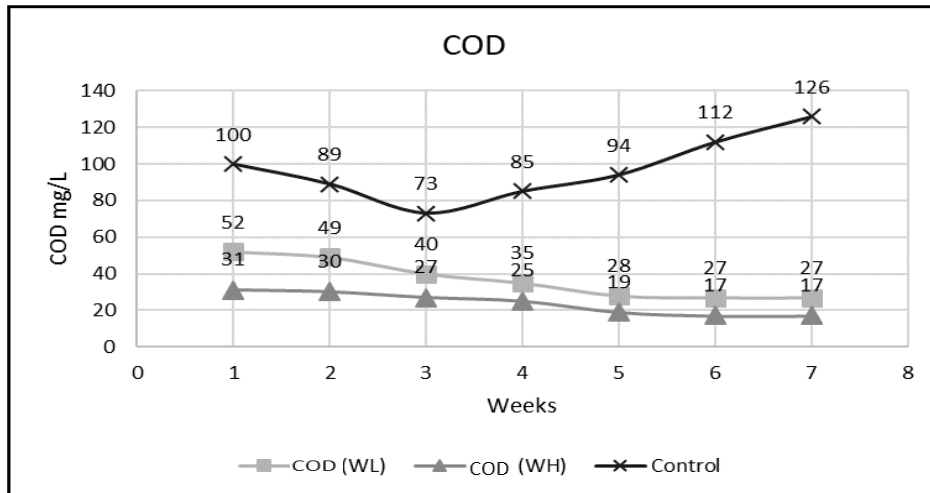
Figure 2. COD concentration between two types of plants for 7 weeks graph

Chemical oxygen demand needs to be carried out in this study because BOD only measures the amount of oxygen consume by microbial to decompose organic matter, but COD can measure the oxygen needed for decompose inorganic matter. The total time taken to measure COD is about 2 to 3 hours which is more rapid than BOD test which takes five days for computation. This is the reason why COD is more widely chosen parameter to examine water quality [10]. Figure 2 depicts that both plants had the ability to decrease the COD concentration of the tested water sample. From week 1, water hyacinth takes the lead since it decrease the COD concentration to 31mg/L from initial 100mg/L while water lettuce only decreases the COD concentration to 52mg/L. This research also shows that both plants had reach 60% of COD removal efficiency and this result are expected with the research carried out by Lu in China. In figure 2, the control tank shows the COD concentration first decreased in the first 3 week but increase dramatically in the rest of the weeks. This abnormal increase can be explained by the growth of algae. Algae had release large amount of dissolved organic matter that cause the increase of COD level. This explanation is taken from Lu's research since its result also shows increase COD level in control pond [8].
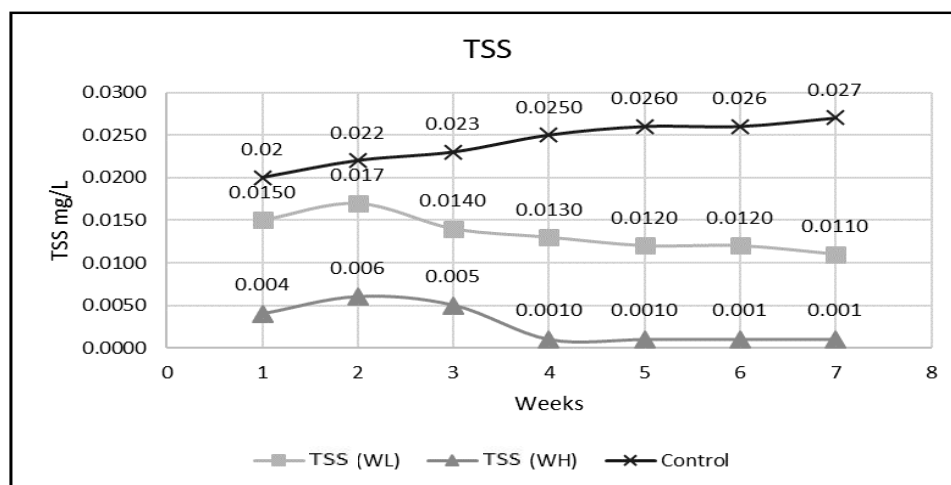

Figure 3. TSS concentration between two types of plants for 7 weeks graph

Mostly, TSS consists of inorganic materials such as bacteria or algae. Sediment, silt and sand are also described as particles of suspended solid. It is important to carry out this parameter to evaluate the water quality of lake water sample because TSS are a significant factor that can affect the clarity of a water sample. The higher the suspended solid presence, the less clear the water will be [4].

From the figure 3, the TSS of the original lake water sample shows only 0.02mg/L. This indicates that the water sample obtained from the lake is still clarify as clear. However, after treatment with phytoremediation with water lettuce and water hyacinth, both plants had successfully reduce the TSS of the lake sample in the first 4 weeks. There are a slightly increase of TSS concentration at week 2 because there are some of the plant species found withered due to lack of nutrients content. The concentration of TSS of both plants is decreasing after week 5 until week 7.

4. Conclusion

As a conclusion justified with the findings of laboratory results, phytoremediation process using water lettuce and water hyacinth is proven to be an effective method to reduce nutrients content from the lake water at KotaSAS lakeside. From the analysis done, it can be concluded that different type of plant had different level of preference on specific parameters. In this research, water hyacinth tops the table as the most effective plant species in not only nutrients content removal while also high removal efficiency on BOD5, COD, TSS, Turbidity and heavy metal. The removal efficiency of parameters BOD5, COD, TSS, Turbidity, Nitrate, Phosphorus, Zinc and Iron are 70%, 76%, 89%, 72%, 83%, 82%, 87% and 80% respectively. By comparing with the control without phytoremediation, the control tank had been attacked by algal growth which lead to increase in COD, TSS, Turbidity and Phosphorus. This reduce the water quality and obviously if the lake water is not undergoing any proper treatment, it will end up with serious eutrophication.

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