# TREATMENT OF LEACHATE USING CULTURED SPIRULINA PLATENSIS

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## *ABSTRACT*

*Among major potential environmental impacts related to leachate is contamination of groundwater through infiltration of organic and inorganic compounds which are transported in the leachate. Ground water table should be free from contamination as it makes up to about 20% of the world's fresh water supply, which makes it an important resource as natural storage that can buffer against shortages of surface water. This research was conducted to determine the capability of Spirulina Platensis to remove pollutants from leachate. The study was carried out by using cultured Spirulina Platensis as a biological treatment for the leachate taken from Jeram Landfill in Kuala Selangor. The optimum condition for culturing spirulina is at about 25.7°C, with DO of 3.36 mg/L, and pH of 9.28. This treatment was conducted in the laboratory under lighted condition. An aeration pump was installed to enhance the aeration process in order to increase the oxygen level. The aeration process has the ability to reduce time of treatment. From this study it was found that the cultured spirulina has significantly increased the water quality as it reduces up to 27% of COD, 53% of BOD and 86% of TSS while improving the pH, by 10%. Spirulina Platensis is also capable of removing about 64% Lead and 63% Zinc.*

***Keywords**: Spirulina Platensis, leachate, landfill*

## INTRODUCTION

Landfill leachate is liquid that drains from a landfill. This liquid may either exist already in the landfill, or it may be created after rainwater mixes with the waste. Modern landfill sites require that the landfill leachate be collected and treated. Since there is no method to ensure that rainwater cannot enter the landfill site, landfill sites must have an impermeable layer at the bottom. The landfill leachate that collects at the bottom must be monitored and treated. This liquid can be treated in a similar manner to sewage, and the treated water can then be safely released into the environment. Meeting progressively more stringent discharge requirements is a difficult task for any landfill. Studies have been made and several methods have been developed to treat leachate. However, conventional techniques, such as chemical precipitation, ion exchange, activated carbon adsorption and membrane separation processes have limitations for the removal of heavy metals from wastewater. They become inefficient and expensive especially when the heavy metal concentration is less than 100 ppm [11]. The ability of microorganisms to accumulate metal ions from aqueous solutions has been widely reported. [13, 16]. Spirulina has been proven to treat wastewater by degrading the organic matter and heavy metals. Spirulina is a tiny blue-green algae in the shape of a perfect spiral coil. Biologically speaking, it is one of the oldest inhabitants of the planet. Its scientific name is Arthrospira Platensis. Appearing 3.6 billion years ago, it provided an evolutionary bridge between bacteria and green plants. It is a potential alternative to conventional processes for the removal of metals hence treating leachate in general.

## MATERIALS AND METHODS

### Culturing Spirulina Platensis

*Spirulina platensis* is a cyanobacteriam that has high protein content and therefore, a high nutritional value. It can be cultivated either in a liquid or in a solid culture [11]. The sample of cultured spirulina was obtained from the biotechnology laboratory. The condition for culturing spirulina however, needs to be maintained in order to make sure that the microorganism is alive during the treatment process. Before starting the treatment, the spirulina were placed in conical flasks that were put on the orbital shaker and under the fluorescent lighting. The optimum temperature for culturing the spirulina was maintained at 25.7°C, from average value. This complies to the statement by Goksan et al. (2007) the optimum temperature for spirulina is in the range of 15 – 35°C. Figure 1 shows the spirulina during the culturing process in the conical flask and Figure 2 shows the spirulina under microscope.


*Figure 1*

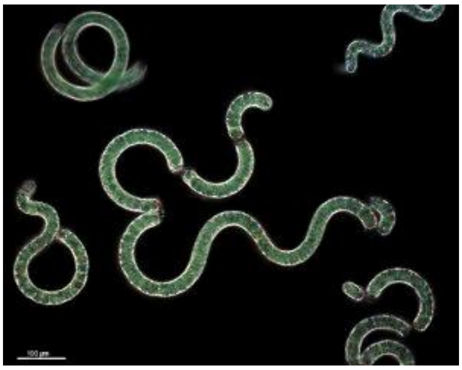

*Figure 2*

*Figure1: Spirulina during the culturing process in the conical flask and Figure 2 spirulina under microscope.*

## Treatment of leachate using cultured spirulina

The experiments were carried out for 21 days. Sampling was done after 7 days of treatment for 14 days (day 21). The analyses were considered on the percentage of removal of the parameters of water quality like the COD, BOD and pH. The ratio of leachate to spirulina used is 3 to 2 as per previous study done by Chen and Pan, (2005). A filtration pump was installed to centrifuge at 2.4 rpm. The whole process of treatment was carried out at room temperature and under lighted condition using 125watt white fluorescent lamp to maintain the optimum condition for the spirulina to be cultured. The filtration pump was also installed to enhance the production of oxygen. Figure 3 shows the schematic layout of the experiment.

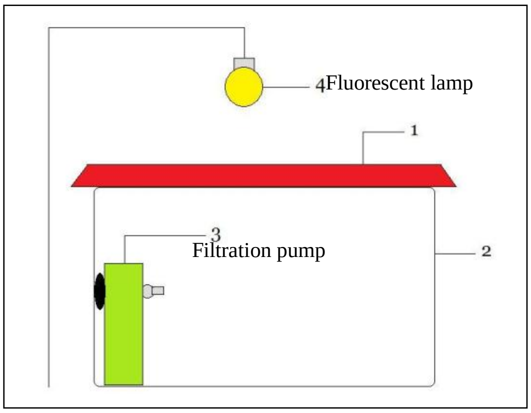


*Figure 3: Schematic layout of the experiment*

*Figure 4: Leachate treatment plant in Jeram landfill*

The sample of leachate was taken from the Jeram Landfill in Kuala Selangor as per Figure 4. The leachate was then analyzed to obtain the quality of water before the treatment stated.

## RESULTS AND DISCUSSION

The laboratory analysis of the leachate is required to determine the effectiveness of pollutants removal using cultured spirulina. The untreated leachate which was obtained from Worldwide Landfill in Jeram, Kuala Selangor was analyzed to determine it's current condition and qualities. The removal efficiency of Lead ranges from 4.3 to 5.33 mg/L as illustrated in Figure 4.11. The result for lead showed a removal of about 64%. The biosorption studies showed that algae had a great potential for adsorbing the heavy metal on to the cell and indicate the possibility of the algae to be a good biosorbent. Effluent of discharge must comply with Standard B which was 100 mg/L of limit discharge, according to Environment Quality Act (1974).

Percentage of removal and compliance with Malaysian discharge for the treatment was summarized in Table 4.2. According to Environment Quality Act (1974), the effluent must comply with Standard B which is discharged into any other inland water or effluent in downstream. As shown below, after being treated with the cultured spirulina, some of the parameters did not comply with the discharge limit. The percentage of removal, however, shows the increment. A longer retention time is required to remove the three parameters that were not complying with the discharge limit. It can be concluded that treatment by using cultured spirulina can remove all the parameters ranging from 10 % to 86 % (at the end of treatment). TSS was the most effectively removed from the leachate, followed by $BOD_5$, lead and zinc. The lowest percentage of removal on this treatment was pH and COD which is 10% and 27% respectively. The study showed that treatment by using cultured spirulina is capable of removing all these parameters.

*Table 1: Percentage of Removal & Compliance with Malaysian Discharge for Standard B*

| Parameter | Unit | Influents (Before Treatment) | Effluents (After Treatment) | Percentage of Removal (%) | Compliance with Malaysian Discharge for Standard B |
|---|---|---|---|---|---|
| pH | - | 7.72 | 8.50 | 10 | Below Limit |
| COD | mg/L | 1222 | 890 | 27 | Above Limit |
| $BOD_5$ | mg/L | 15.97 | 7.49 | 53 | Below Limit |
| TSS | mg/L | 27227 | 3700 | 86 | Above Limit |
| Lead | mg/L | 13.3 | 4.8 | 64 | Above Limit |
| Zinc | mg/L | 15.2 | 5.6 | 63 | Above Limit |

## CONCLUSIONS

There were several conclusions that can be drawn in this study. The optimum condition for culturing spirulina based on temperature, dissolved oxygen (DO) and pH value. After 5 days (cultured), the characteristic of spirulina at temperature of 25.7$^o$C, 3.36 mg/L of DO, and 9.28 of pH is considered stable. In addition, the colour of the conical flask cultures turned to green after 5 day growth indicating that the spirulina is healthy and alive. After the treatment, Spirulina Platensis showed great potential in removing BOD, Lead, Zinc, and TSS in leachate. After 7 days of treatment, Spirulina Platensis started showing some removal of BOD and TSS in water quality analysis which was 53% and 86%, respectively. The cultured spirulina also reduced 10% of pH, and 27% of COD in leachate. The cultured spirulina has the ability to treat leachate and can reduce the water quality parameters in leachate. The result showed that COD, TSS, lead, and zinc does not fulfil the Standard B for discharge to the river. The potential of reducing the concentration of heavy metal, however is very high if the retention time was extended. It showed that the algae had a great potential for reducing the heavy metal on to the cell. The cells of spirulina were also found to have high potential for removing lead and zinc. However, there are still many uncertainties associated with the treatment of leachate by algae and more detailed investigation is required.

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