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# LANDFILL LEACHATE TREATMENT BY WHITE ROT FUNGI

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A Thesis Presented

by

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Doctor of Philosophy
Environmental Technology Program
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Sirindhorn International Institute of Technology
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# Abstract

White rot fungi produces various isoforms of extracellular enzymes including laccase, manganese peroxidase and lignin peroxidase that can degrade the pollutants and, thus, can be used to treat wastewater, including landfill leachate. In this research, the treatment of leachate by using white rot fungi, namely *Trametes versicolor* BCC 8725 and *Flavodon flavus* BCC 17421 was studied. Four types of leachate were collected in different time period and different source from Nonthaburi solid waste disposal site, Thailand. Leachate differs in terms of color, BOD, COD. The fungi were immobilized on polyurethane foam (PUF). Glucose, corn starch and cassava were used as a co-substrate and were varied at different concentration. Batch experiments were done to determine the optimum pH, co-substrate and effect of contact time. Continuous experiments were carried out using vertical flow baffled reactor to observe the effect of organic loading, reuse of fungi in various cycles and its possibility to use in large scale leachate treatment. The effect of biomass growth was observed by immobilizing fungi on PUF for different time periods (for 4 and 15 days initially in Potato Dextrose Broth (PDB). The same immobilized fungi were used for four cycles of 5 days each to find the reuse of fungi. Leachate was diluted to see the effect of organic loading on color removal.

Results of batch experiment indicated that the optimum pH, where maximum color removal could be obtained, is 4 and glucose is the best co-substrate at 3 g/L with contact time of 15 days. *T.versicolor* BCC 8725 could decolorize 62-79% and BOD and COD of 43%-57% for various types of leachate used in this study when using 3 g/L of glucose. Laccase was the main enzyme which contributed to the decolorization of leachate by *T.versicolor* BCC 8725. Color removal rates were proportional to the enzyme activity.

In continuous experiment, the same immobilized fungi on PUF could be reused for at least 4 cycles (1 cycle of 5 days each). Dilution of leachate that collected from the pipe as discharged from the landfill to the stabilization pond did not significantly increase the removal efficiency when glucose was not added. About 8% and 15% higher color removal was obtained without and with glucose when using 5-time diluted leachate (600 mg/l of glucose, with 4-day immobilization). About 1-6% higher color removal efficiency was obtained when fungi was initially immobilized in PDB for 15-day as compared to 4-day immobilization. Removal efficiency was also calculated in terms of mg of COD and BOD removal per mg of biomass. Concentrated leachate (3 g/l glucose as co-substrate, with 4-day immobilization) gave the highest removal of 0.6 mg COD per mg of biomass and 0.45 mg BOD per mg of biomass. Thus, fungi are good in degradation of complex organic compounds that are not readily biodegradable as high COD removal was observed compared to the BOD.

This study demonstrated a novel process which provides an alternative way of managing leachate since it is the natural biological process. However, fungi used in this study cannot completely remove color, BOD and COD from leachate. Thus, it is required to couple with another treatment process.

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## List of Symbols and Abbreviations

| | |
|---|---|
| AIT | Asian Institute of Technology |
| ABTS | 2,2′-azinobis(3-ethylbenzthiazoline-6-sulfonate) |
| AOP | Advanced Oxidation Processes |
| BCC | Biotech Culture Collection |
| BOD | Biological Oxygen Demand |
| C | Cassava |
| COD | Chemical Oxygen Demand |
| Cd | Cadmium |
| Cr | Chromium |
| CS | Corn starch |
| *F.flavus* | *Flavodon flavus* |
| G | glucose |
| HCl | Hydrochloric acid |
| Hg | Mercury |
| HRT | Hydraulic Retention Time |
| ICP/MS | Inductively Coupled Plasma Mass Spectrometry |
| IPUF | Immobilized Polyurethane Foam |
| Lac | Laccase |
| LiP | Lignin Peroxidase |
| MnP | Manganese Peroxidase |
| Na | Sodium |
| NaOH | Sodium Hydroxide |
| Ni | Nickel |
| $NH_3$ | ammonia |
| OLR | Organic Loading Rate |
| Pb | Lead |
| PCD | Pollution Control Department |
| PDA | Potato Dextrose Agar |
| PDB | Potato Dextrose Broth |
| PUF | Polyurethane foam |
| TKN | Total Kjeldahl Nitrogen |
| *T.versicolor* | *Trametes versicolor* |
| TCLP | Toxicity Characteristic Leaching Procedure |
| SEM | Scanning Electron Microscope |
| SS | Suspended Solids |
| SBOD | Soluble Biological Oxygen Demand |
| SCOD | Soluble Chemical Oxygen Demand |
| WRF | White Rot Fungi |
| Zn | Zinc |

## List of Units

| | |
|---|---|
| ADMI | American Dye Manufacturer Institute |
| cm | centimeter |
| d | day (s) |
| g | gram |
| g/l | gram per liter |
| kg | kilogram |
| h | hour(s) |
| min | minute |
| mg | milligram |
| mg/l | milligram per liter |
| ml | milliliter |
| ml/min | milliliter per minute |
| mm | millimeter |
| l | liter |
| rpm | round per minute |
| % | percent |