Phycoremediation of Landfill Permeate: Nutrient Limitation

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Abstract

Every landfill produces leachate, composed of liquid that accumulates at the bottom of a landfill after it has percolated through the solid wastes. Permeate, which will be used in this experiment, is obtained by filtering landfill leachate through a reverse osmosis filter. This is the first step in the current two-stage experimental process at the Alachua County Southwest Landfill . The culture that will be utilized is a native polyculture that was collected on site. This experiment investigates the possibilities of using microalgae as a biological pathway for remediating landfill permeate as well as explores the functional consequences of nutrient limitations.

Introduction

•Groundwater is a precious resource that is decreasing rapidly around the world, which emphasizes the need to remediate water.

•There are thousands of landfills in the United States that are all producing leachate, which must be remediated.

•Algae can be cultivated to remediate wastewaters (FAO 2009).

• Alachua County SW Landfill (ACSWL) is currently using an experimental two phase reverse osmosis (RO) system to remediate leachate. The product from the first phase will be referred to as RO permeate.

• Preliminary experiments have shown that the algae are remediating permeate. These exciting results have encouraged further studies to optimize the algal remediation of permeate. It is hypothesized that the growth of algae in RO permeate is limited due to nutrient deficiencies.

Objectives

1. Demonstrate the ability of microalgae to remediate permeate.
2. Show that there is a nutrient limitation in permeate.
3. Demonstrate that the additions of growth media can dramatically increase the effectiveness of the algae to remediate permeate.

Methods

• *Algal Cultivation:* Native algae (Figure 1), collected at ACSWL, were cultivated in 125mL Erlenmeyer flasks under 24 hour illumination at 150uE/m^2/s, and were mixed by aeration An inoculation density of 10% by volume was used to initiate the algal culture. Experimental treatments consisted of triplicate cultures grown in RO permeate, RO permeate + 10% Bold's Basal Medium (BBM), a standard growth medium for algae (Anderson 2005), and RO permeate + 10% BBM –phosphorous only (BBM-P Only).

• *Algal Growth:* Culture growth was monitored by optical density at 680nm using a thermo-fisher Genesys 10UV-Vis spectrophotometer.

• *Total Ammoniacal Nitrogen (TAN):* TAN was measured using an ammonia selective electrode (Orion 95-12) according to APHA (2005) standard methods 4500-NH3.

• *Culture pH:* pH was measured in accordance with APHA standard method 4500-H+.

Results

•Reverse osmosis (RO) permeate does not have all of the nutrients necessary for optimal algae growth (Figure 2).

•The addition of BBM dramatically increases the growth of the algae on permeate (Figure 3). This allows for faster remediation (Figures 4 and 5).

•Simply adding the phosphorus component of BBM did not solve all of the nutrient limitation issues. Indicating that other nutrients, aside from phosphorus, are lacking in RO permeate and are preventing optimum growth and remediation.

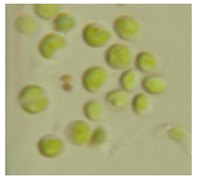

Figure 1. Native algae culture used in RO growth experiments

Figure 2. Appearance of culture grown on RO permeate, RO permeate +10% BBM-P only, and RO permeate + 10% BBM media (from left to right).

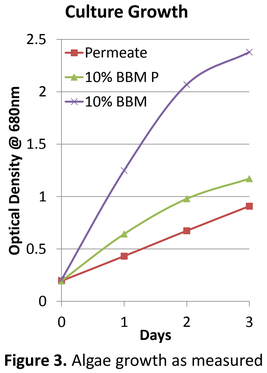

Figure 3. Algae growth as measured by optical density within RO Permeate, 10% BBM-P, and 10% BBM media.

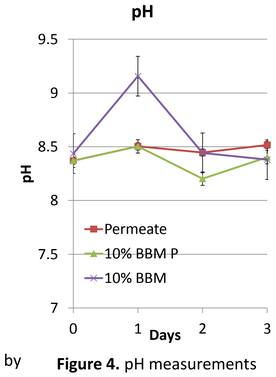

Figure 4. pH measurements within RO Permeate, 10% BBM-P, and 10% BBM media.

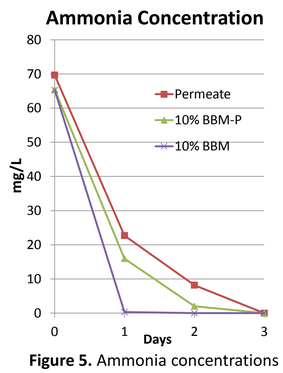

Figure 5. Ammonia concentrations within RO permeate, 10% BBM-P, and 10% BBM media.

Conclusions

•The RO permeate is nutrient deficient

•Limiting nutrients limit the growth of the algae

• Phosphorus alone does not account for the limitation

• Growth limitation of algae limits remediation capacity

• Algae need complete nutrition for effective remediation

• An addition of nutrients increases the growth rates of algae, which increases the remediation capacity of algae.

Future Work

More research needs to be done on optimizing the growth of algae on permeate and determining exactly what nutrients are missing in order to achieve optimal growth and remediation. This experiment also needs to be scaled up to a larger volume to ensure the same results. Addition of CO_2 may increase the remediation capacity of the algae further. The effect of the duration and intensity of illumination on remediation time should be investigated.

References

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Acknowledgements

This research was part of the 2011 BioEnergy and Sustainability School (BESS), a summer internship program funded by the Florida Agricultural Experiment Station, UF/IFAS.