Landfill Leachate Induced Dissolved Organic Nitrogen and Its Impact on Algal Growth

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Background

- DON, which is non-bioavailable and excluded from eutrophication-related loading budgets, can degrade water quality and harm aquatic ecosystems in nitrogen-sensitive environments (Osburn et al., 2016).
- Aquatic DON—amino acids, urea, and humic substances—promotes phytoplankton and bacteria growth (Maie et al., 2006).

Figure 1: Eutrophication in a lake at Greensboro, NC

- Nitrogen additions worsen cyanobacterial blooms in rivers, estuaries, and Albemarle Sound in North Carolina (Plaas, 2021; Tobb, 2022).
- Landfill leachate nitrogen contributes to aquatic eutrophication, but its effect on phytoplankton growth is unknown (Price et al., 2018).
- This study analyzed DON fate in an SBR-treated wastewater and landfill leachate blend, followed by in-situ algal bioassay using Neuse River water..

Research Methodology

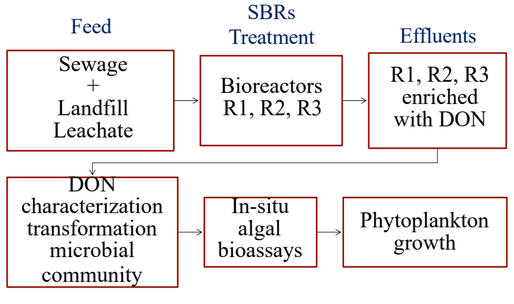

Figure 2: SBRs process with in-situ algal bioassays

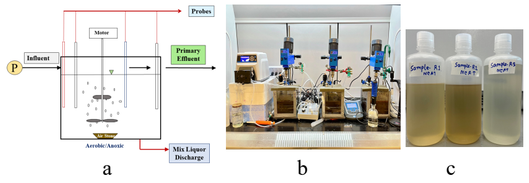

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Figure 3: a) SBR schematic diagram, b) Reactor's lab setup, c) Three effluents

Research Methodology

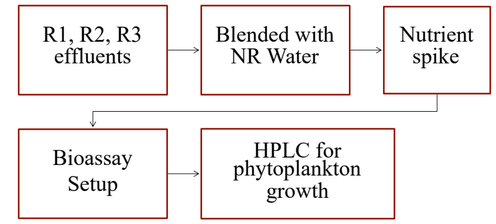

Figure 4: In-situ algal bioassay process

Figure 5: Algal bioassay setup in pond incubation

Results

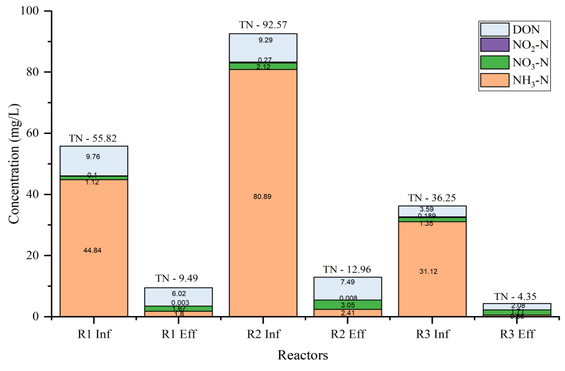

Figure 6: Influent and effluent nitrogen species of the SBRs

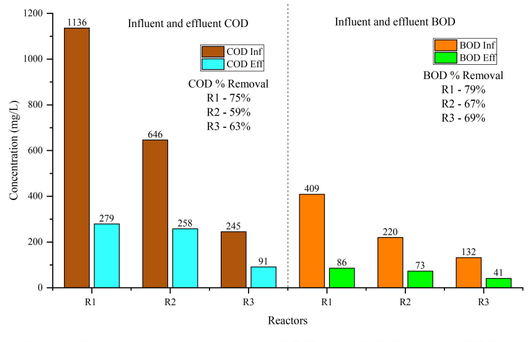

Figure 7: Influent and effluent COD and BOD of the SBRs

Results

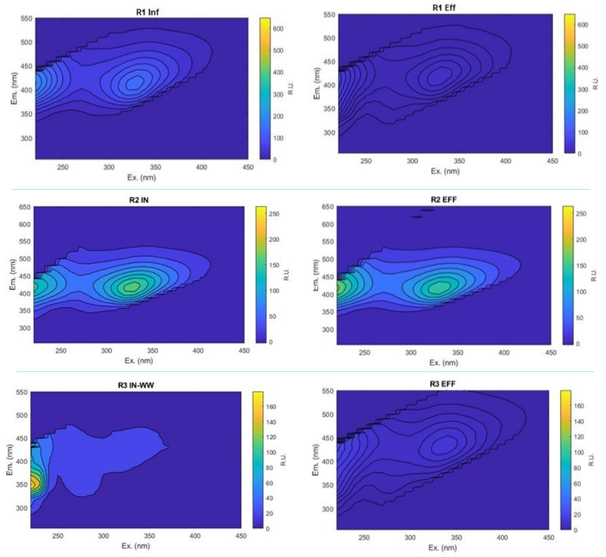

Figure 8: Excitation-emission matrix of R1, R2, and R3 effluents

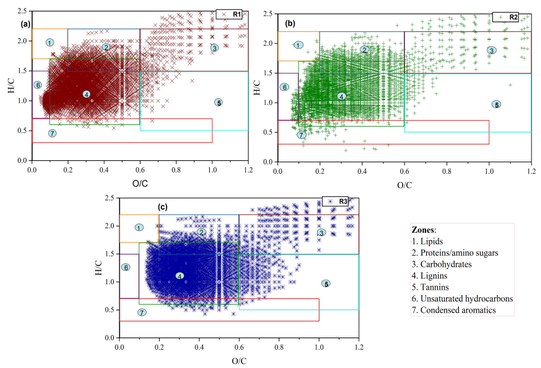

Figure 9: Van Krevelen diagrams of DON from FTICR-MS analysis

Table 1: PARAFAC modeling output: Reactor 1

R1	Component 1 Humic-like	Component 2 Humic-like and Fulvic-like	Component 3 Aromatic proteins II
R1-In	17.1	103.8	38.2
R1-Eff	3.9	23.0	36.4

Table 2: PARAFAC modeling output: Reactor 2

R2	Component 1 Humic-like and Fulvic-like	Component 2 Humic-like	Component 3 Aromatic proteins II
R2-In	34.6	94.8	154.6
R2-Eff	32.5	73.3	59.3

Table 3: PARAFAC modeling output: Reactor 3

R3	Component 1 Aromatic proteins II (Lignin)	Component 2 Humic-like and Fulvic-like (Cellulose)
R3 In	179.05	33.8
R3 Eff	22.54	15.24

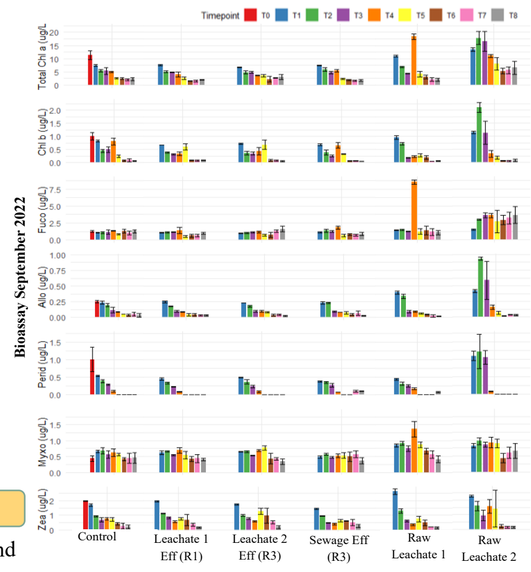

Figure 10: Algal Bioassay report (HPLC analysis)

Conclusion

- For R1, R2, and R3, the SBR system removed TN at 83, 86, and 88% and COD at 75, 59, and 63%.
- PARAFAC modeling showed that SBRs removed large amounts of humic, fulvic, and aromatic proteins II.
- FTICR-MS analysis showed that reactors R1 and R2 had lignin and proteins/amino sugars in their DON, while reactor R3 had carbohydrates and tannins along with them.
- Refractory DON compounds in R1, R2, and R3 effluents may explain the low algal growth in short term bioassays. Inorganic nitrogen-enriched leachate samples grew algae. Raw leachate 2 outgrew leachate 1 in fucoxanthin, chlorophyll b, alloxanthin, and peridinin.

Acknowledgement

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