Optimizing Production of *Moringa oleifera* F-sand for Removing Nutrients from Eutrophic Lakes

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Introduction

- Eutrophication is the process of large-scale algal blooms in aquatic environments caused by the introduction of excess nutrients (Nitrate and Phosphate)
- This process results in hypoxia, the depletion of dissolved oxygen, which kills pre-existing plants and animals
- *Moringa oleifera* seeds are high in Moringa Oleifera Cationic Protein (MOCP), a positively charged protein that can be separated and dissolved into water
- Studies have shown that when mixed with negatively charged substrate, aqueous MOCP can adsorb, or "stick", to the surface of the substrate, reversing its charge (Figure 2)
- Nitrate and Phosphate are negatively charged, meaning the now positively charged substrate can be used as a functional sand (f-sand), attracting and immobilizing the nutrients
- This process has the potential to be utilized as a cheap, natural alternative for the current, expensive nutrient removal processes
- We set out to optimize the creation of the *Moringa oleifera* f-sand to take the first steps towards large scale deployment of this filtration agent

Figure 1: An image of Lake Munson, a south Tallahassee lake heavily affected by eutrophication

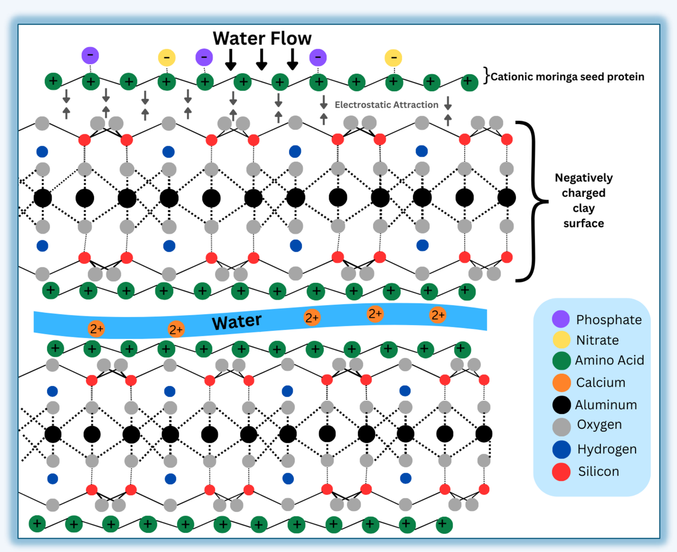


Figure 2: A diagram of the electrostatic relationship present between substrate and MOCP

Methods

- We began with intensive literature review to gather any existing information regarding *Moringa oleifera* and its electrostatic role in f-sand.
- In addition, we used knowledge of previous experiments to design an efficient, scalable production method for f-sand creation.
- Using this knowledge, we devised experiments using different to determine which would be the most effective in nutrient uptake with adsorbed MOCP.
- We then tested varying amounts of MOCP concentrations, creating batches of f-sand and adding them to aqueous solutions of phosphate and nitrate.
- We measured the results of these tests using an Ion Chromatographer (IC) and structured time sampling to measure the amounts of nutrient uptake over time.

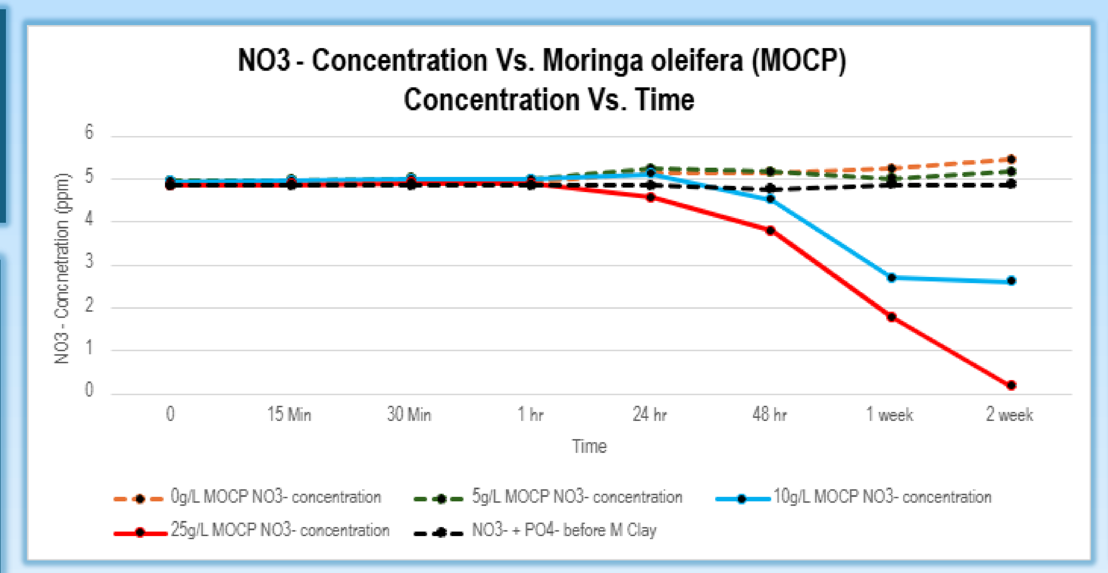


Figure 3: NO3- Concentration Vs. Moringa Olifera (MOCP) Concentration Vs. Time

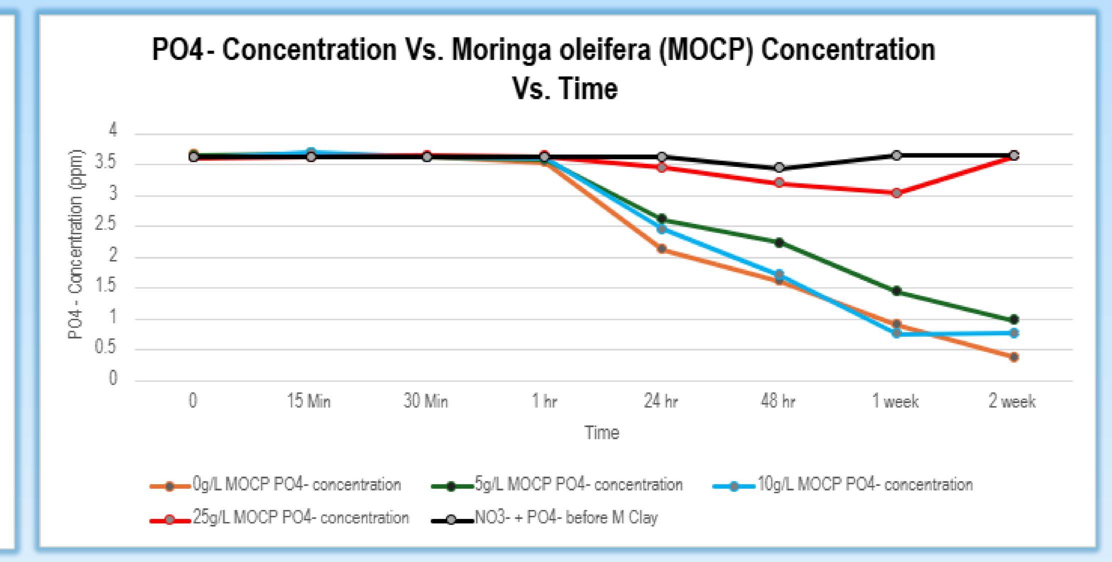


Figure 4: PO4- Concentration Vs. Moringa Olifera (MOCP) Concentration Vs. Time

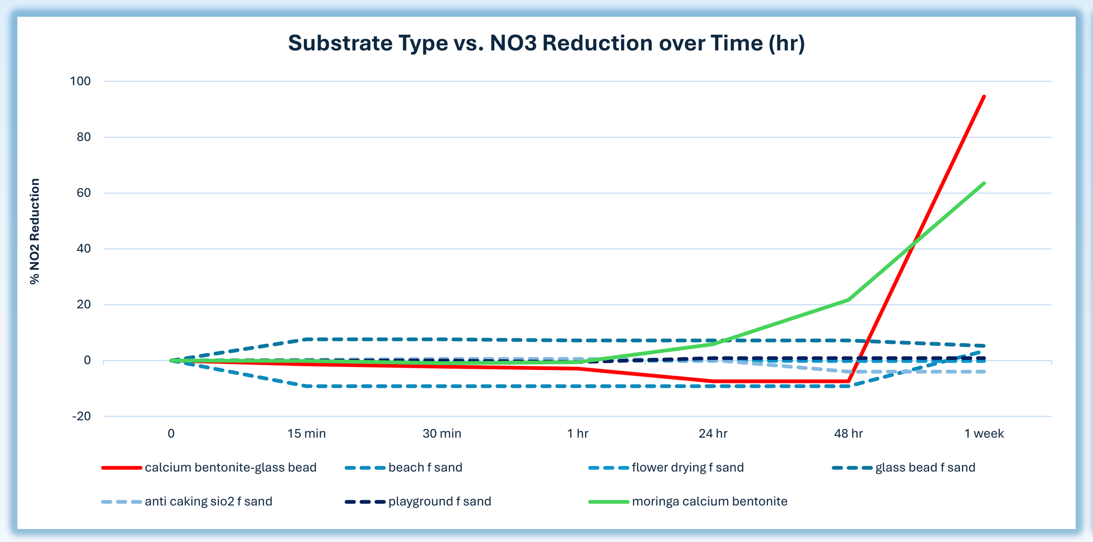


Figure 5: Substrate vs. NO3 Reduction over Time (hr)

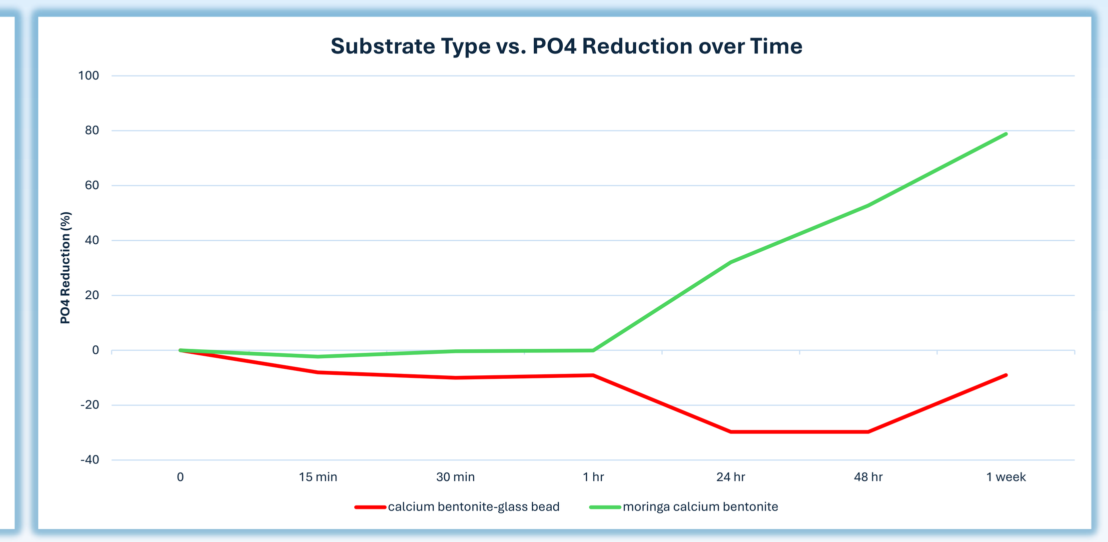


Figure 6: Substrate Type vs. PO4 Reduction over Time

Figure 7: Moringa Olifera Protein Extract in laboratory

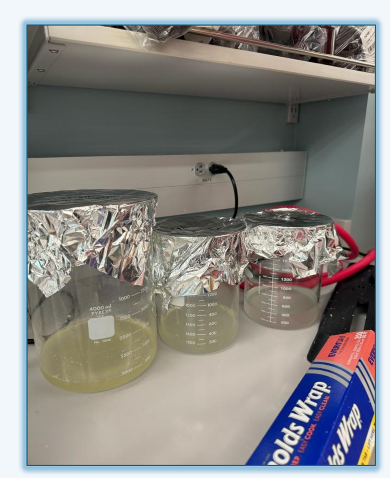
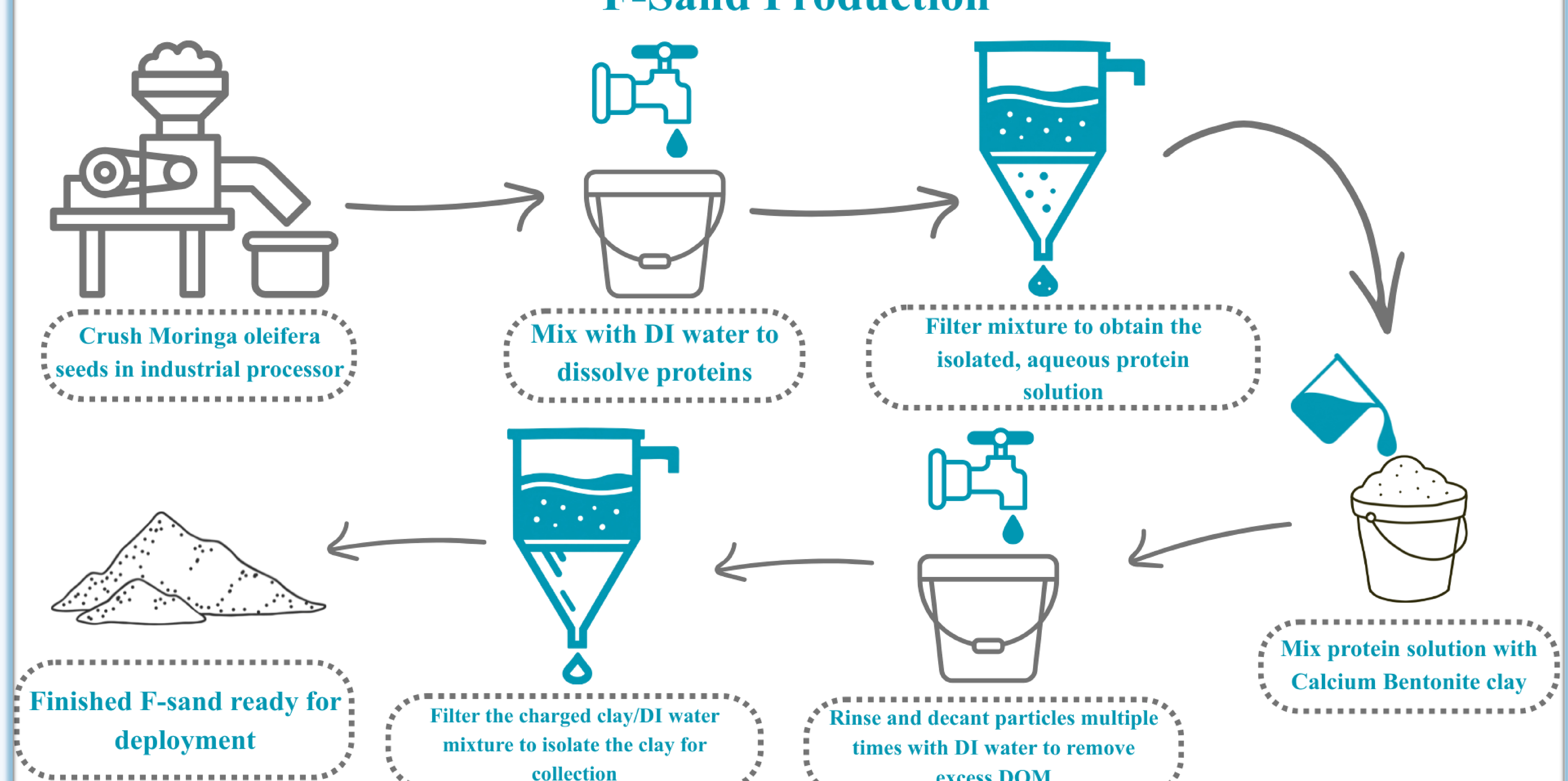


Figure 8: Concentration experiment (15 mL, 10 mL, 5 mL)

Figure 9: Mixing time experiment

Figure 10: Ion Chromatographer used for data collection

F-Sand Production



Results

- The results have not yet been finalized, but when they are, they will show the best methods for creating f-sand to optimize its adsorption of phosphate and nitrate. The results will also show that f-sand has been proven effective in the reduction of nitrate and phosphate in water. Our results will include data from testing the effectiveness of various substrates, concentrations, and mixing times, measured using ion chromatography.

Discussion

- While results are not finalized, our current findings express the potential of MOCP f-sand to be the first scalable, cost-effective agent in mitigating eutrophication.
- With methods that prove optimization of adsorption can be achieved, there is hope for future improvement of the use of f-sand in large-scale employment around not just local lakes, but bodies of freshwater all around the world.
- With eutrophication continuing to affect environmental and human health, f-sand presents itself as an essential player in environmental sustainability.

References & Acknowledgements

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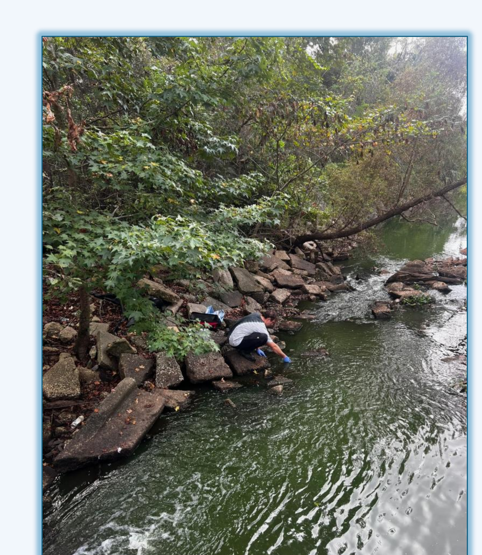

Figure 11: John Stainbrook sampling water from Lake Munson

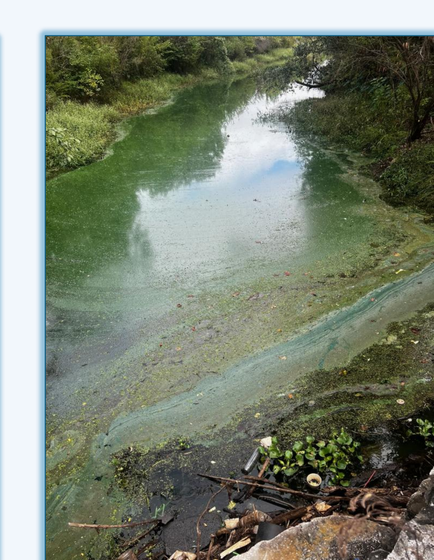

Figure 12: Current state of Lake Munson

References