

The Effects of Cyanobacteria Concentrations on Aerosol Production

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Introduction

- Cyanobacteria are commonly referred to as “blue-green algae” but are actually photosynthetic gram-negative prokaryotes that reside in bodies of water.
- They produce harmful toxins that aerosolize such as BMAA and microcystins linked to neurodegenerative diseases (Callier T. et al., 2009), but cyanotoxins are difficult and expensive to measure.
- Phycoerythrin (PE) is a pigment that can be used as a tracer for cyanobacteria presence and possibly toxins too.
- Many factors influence the rate of aerosolization but are not well studied.
- Previous field studies have shown a potentially negative linear relationship between the concentration of cyanobacteria and the amount of cyanotoxins aerosolized (Langley K., 2019).
- This led to the creation of the “LIM” model – less is more. An acronym that sums up the unexpected correlation between air and water concentration.
- **It was hypothesized that in a controlled lab setting, if the pigment is less concentrated in a solution, then the percentage of pigment aerosolized would be higher**

Methods

Preparation of flasks:

- Dilution series of 6 was created using *Spirulina* powder – a source of PE – calculated based off max amount of pigment that registered on the fluorometer
- Concentrations of *Spirulina* were added to centrifuge tubes containing 45 mL of Milli-Q
- All solutions were vortexed for 2 mins, and then centrifuged for 10 mins
- Solutions were added to flasks containing 955 mL of Milli-Q for a total of 1L (Figure 1)
- PE readings were found for all 6 dilutions

Compact Lake Aerosol Monitor Procedure

- Flasks corked and attached to filter in fume hood
- Each flask connected to CLAM system: vacuum pump and diffusers used to direct air from within flask through three traps in sequence (Figure 2)
- 17 mL of distilled water added to each trap to collect aerosolized pigment from the air
- CLAM air circulation procedure allowed to run continuously for four hours

Analysis of Trap Samples

- Following CLAM procedure, collection of water samples from each trap (18 total) and each flask (6) were obtained
- Pigment analysis repeated for samples from flasks and for samples from traps

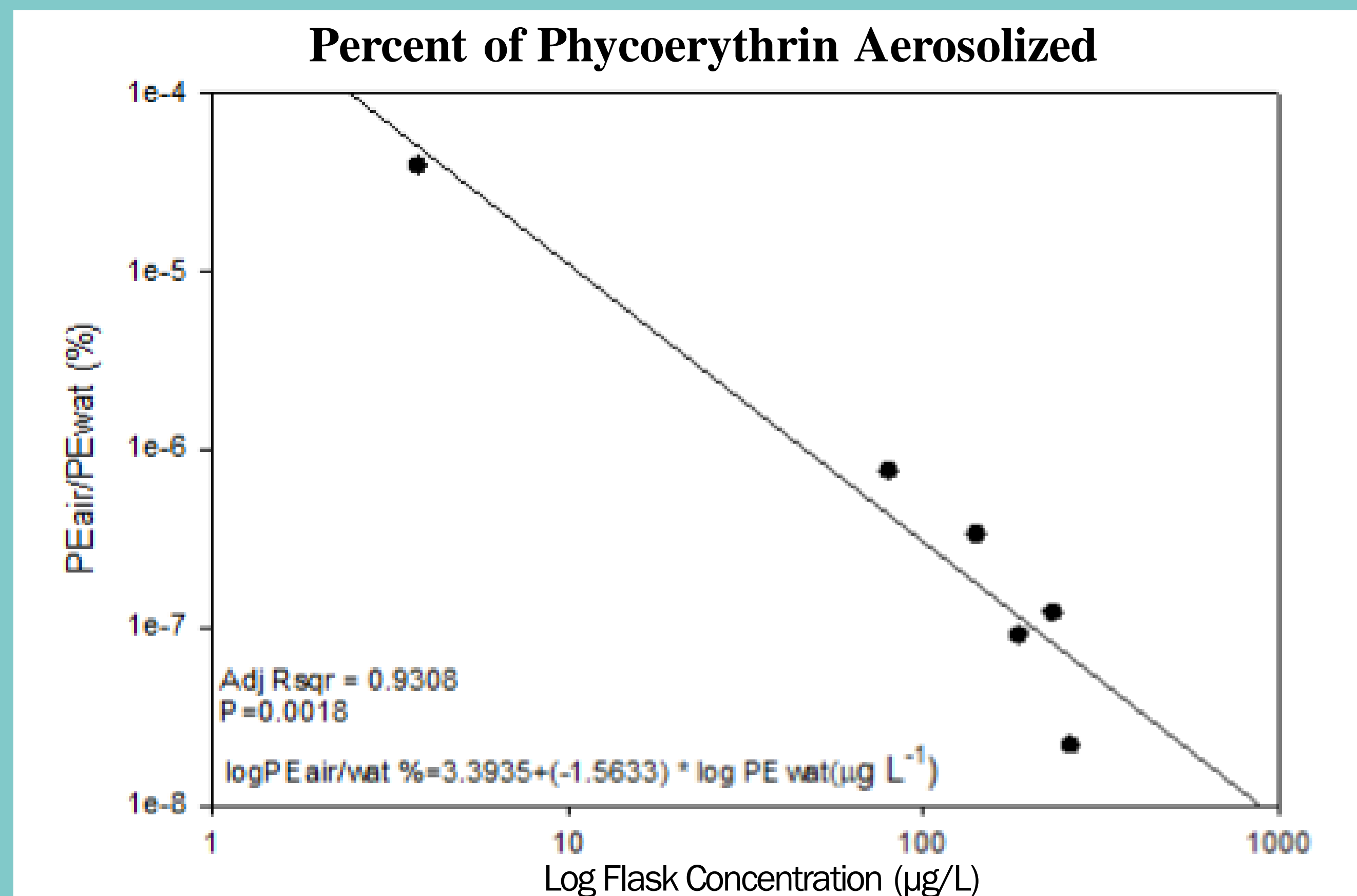
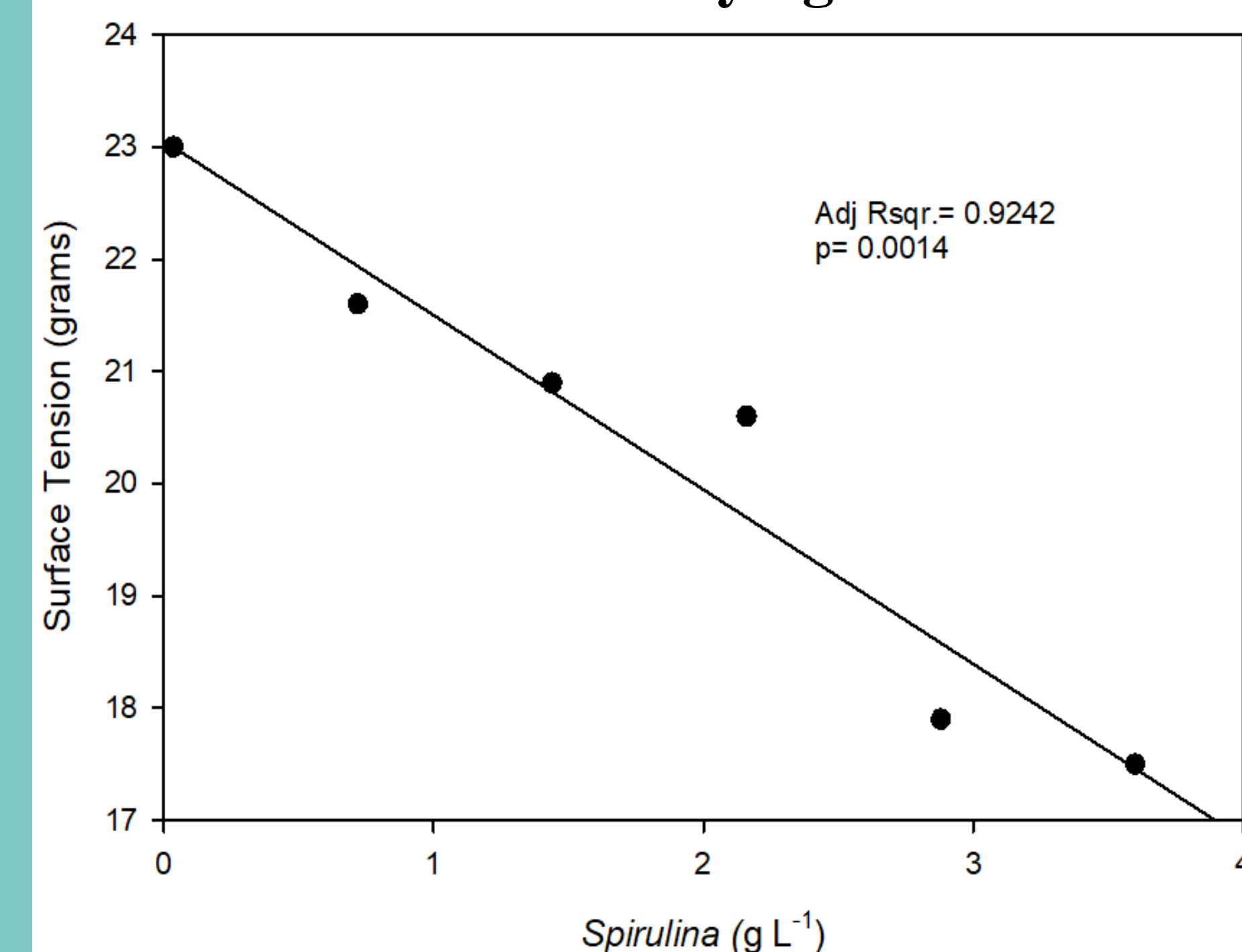


Figure 3. Percent of PE aerosolized with differing concentrations (top left)

Figure 4. Absolute amount of PE aerosolized with differing concentrations (middle left)

Figure 5. Weight it takes to break the surface tension of differing amounts of *Spirulina* powder (right)

Surface Tension of Varying Concentrations



Results

- Significant negative logarithmic trend found between pigment concentration and percent of pigment aerosolized into the traps (Figure 3, p=0.0018)
- Significant negative linear relationship found between total amount of pigment in flask and total amount of pigment in correlating traps (Figure 4, p=0.0087)
- Significant trend found between *Spirulina* concentration and decreasing surface tension (Figure 5, p=0.0014)

Discussion

- **The hypothesis and Langley’s findings are supported – Less is more.**
- Trends show that in lakes with lower concentrations of cyanobacteria, there are more pigments and toxins being released through the aerosolization process relative to highly concentrated lakes.
- The observed trends cause concern as bodies of water that may appear healthy could potentially be releasing higher volumes of cyanotoxins.
- The less is more trend defies laws of diffusion, so more research is needed to further understand why this trend occurs:
 - One hypothesis proposed was the idea of increased concentration also increasing surface tension; however, the opposite trend was found (Figure 5, p=0.0014)
 - Another observation of a layer formed along the surface prompted the theory that the higher concentration could be creating a film, trapping the particles under water.

Acknowledgements and Citations

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- Langley, Katharine. “University of New Hampshire University of New Hampshire Scholars ...”
- Callier, T et al. (2009). A cluster of amyotrophic lateral sclerosis in New Hampshire: A possible role for toxic cyanobacterial blooms. Amyotrophic Lateral Sclerosis. 10:sup2, 101-108

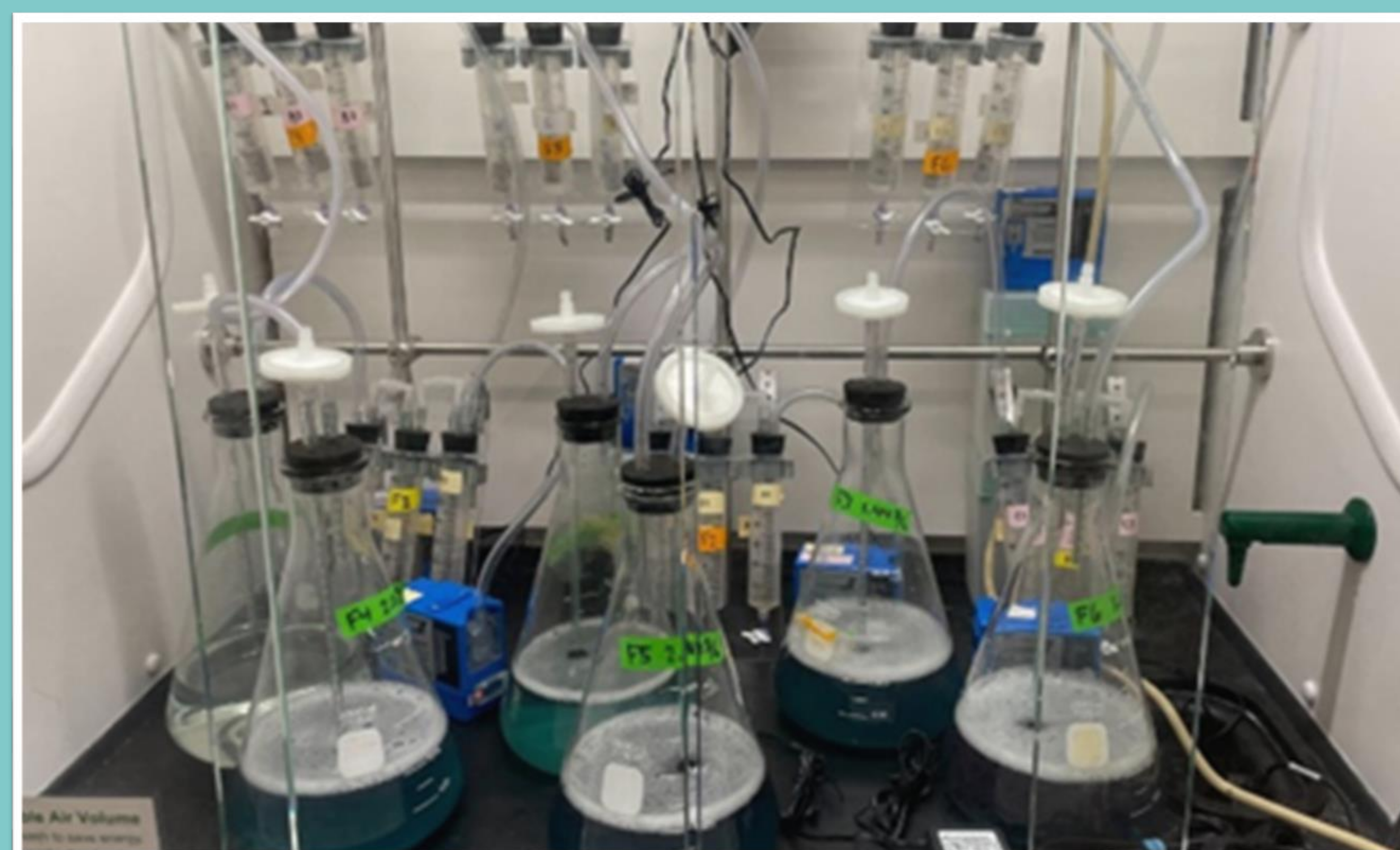
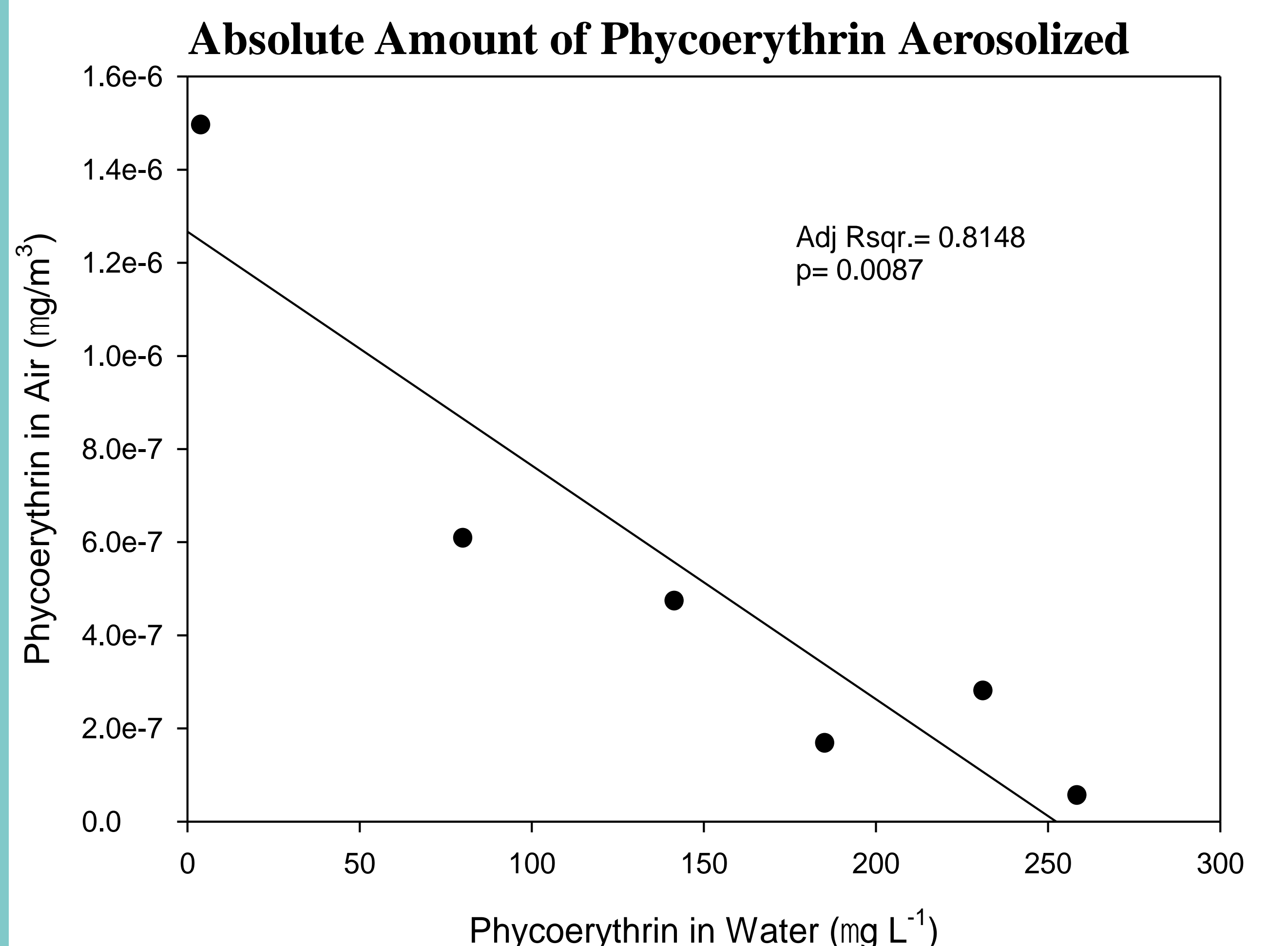


Figure 1. Varying Concentrations of *Spirulina* powder (left)
Figure 2. CLAM setup (above)