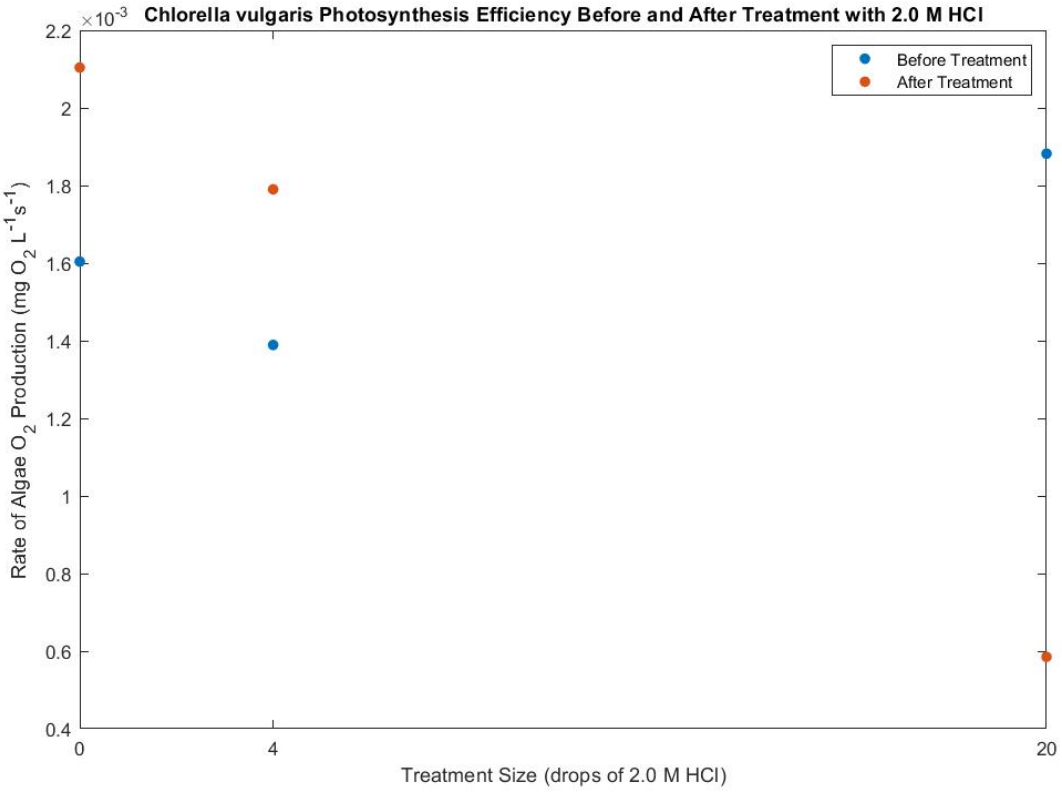
Figure 1



The objective of this experiment was to examine the effect of 2.0 M HCl on the efficiency of photosynthesis in *Chlorella vulgaris*.

The hypothesis was that the addition of 2.0 M HCl would inhibit photosynthesis, and this could be observed by a decrease in the rate of O_2 production the measurement period. The independent variable was the treatment size (drops of 2.0 M HCl, abbreviated to drops), the dependent variable was the rate of algae O_2 production (mg O_2 $L^{-1}s^{-1}$), and the control variables were all of the equipment used and all variables that entails, the stir rate, the observation time, ambient light, environment temperature, and time of treatment application, to the best of our ability. The volume of the beaker contents after the treatment was applied was not controlled, but we were instructed that the volume of the treatment was negligible compared to the 110 mL volume of the pre-treatment beaker contents. The control treatment was the 0-drop treatment; the other treatments were the experimental treatments.

The materials used in this experiment were: one 150 mL plastic graduated cylinder, dH_2O, 60 mL of *Chlorella vulgaris* suspended in water and stored in an opaque container (algae suspension), one container of 2.0 M HCl, one Pasteur pipette, one Pasteur pipette head, one 150 mL glass beaker, one Corning stirrer (stirrer), one magnetic stir bar, one Vernier Optical Dissolved Oxygen (ODO) probe, one stand for the ODO probe, one lamp with a light bulb capable of supporting photosynthesis, and one computer with Logger Pro.

The method was as follows. First, the ODO probe was connected to the computer, and it was verified that Logger Pro was receiving data from the probe. Logger Pro was then configured to collect data for 600 seconds. Next, for each trial, the magnetic stir bar, 90 mL of dH_2O and then 20 mL of algae suspension were added to the beaker. The beaker was then set on the stirrer. The ODO probe was inserted into the beaker and secured to the stand. The stirrer was then set to 4. After that, the lamp was turned on. It was quickly ensured that the lamp was illuminating as large of a surface of the beaker contents as possible, and then Logger Pro was instructed to collect data. For the first 300 seconds, the algae was allowed to perform photosynthesis untreated. At the 300 second mark, the treatment was applied as quickly as safely possible. 300 more seconds of data were collected, and then the trial was terminated.

The raw data was a length 601 array of times, 0 seconds to 600 seconds, and another length 601 array of ODO measurements of dissolved oxygen per liter (mg O_2 L^{-1}). To measure the rate of algae O_2 production, the slope of the best fit line of the first and last 300 seconds of data was recorded. Note that in the 10 seconds of the trial for the 20-drop treatment, there was a sharp decrease in the dissolved oxygen measurements; this data was recognized as transient and discarded when calculating the best fit line.

The control treatment showed that after treatment, the photosynthesis efficiency increased. Without more than one trial, this is difficult to explain, but it is likely that this is the result of random variation in the photosynthesis efficiency. The change in the rate of O_2 production was 5.00×10^{-4} mg O_2 $L^{-1}s^{-1}$. The 4-drop treatment also showed an increase that was likely due to random fluctuations in the photosynthesis efficiency; the change in the rate of O_2 production was 4.01×10^{-4} mg O_2 $L^{-1}s^{-1}$. Finally, the 20-drop treatment showed a sharp decrease in the photosynthesis efficiency; the change in the rate of O_2 production was -1.30×10^{-3} mg O_2 $L^{-1}s^{-1}$, which was an order of magnitude larger than the other changes, and in the opposite direction.

Based on this data, the conclusion is that the addition of 2.0 M HCl does inhibit photosynthesis in *Chlorella vulgaris*.

There are two obvious refinements of this experiment worth mentioning. First, more trials could be taken at each treatment level. This would allow for it to be determined if the random fluctuations cited above really are to blame for the non-zero change in photosynthesis efficiency in the control group. Second, a denser set of treatment sizes could be tested, for example 0, 4, 8, 12, 16, and 20 drops. This would allow for it to be seen if photosynthesis efficiency decreases linearly with increasing drops, or if the relationship indicates some buffering effect, likely internal to the algae cells.