Biodegradation of Methylene Blue Dye by *Platymonas*

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Abstract

I tested the effects of methylene blue dye on *platymonas* algae to see whether it would die, passively survive the methylene blue, or actively biodegrade the dye. The *platymonas* samples not only survived exposure to different concentrations of methylene blue, but biodegraded it and even reproduced after a few weeks.

Introduction

Methylene blue is an environmental toxin that is highly damaging to fish and other aquatic life. *Platymonas* is a unicellular marine microalgae. There have been reports of algae having the ability to biodegrade environmental toxins. An article from Science Reports states "that *Tetradesmus obliquus,"* a similar species of algae to *platymonas*, "showed strong biodegradation ability of the methylene blue (MB) dye" (Talha et. al.). My hypothesis is that if the *platymonas* doesn't immediately die from the exposure, it will break down the methylene blue. Finding a natural way to eliminate methylene blue in waterways would be a great way to protect ecosystems and wildlife from at least some toxic runoff.

Methods

Materials

- 10 drops of 0.01% methylene blue dye solution
- 25 mL of 360,000 cells/mL *platymonas* stock
- 5 test tubes + rack
- Masking tape + sharpie
- Spectrophotometer + cuvettes

Procedure

I started my experiment with five test tubes, each containing 5 mL of *platymonas* stock. One test tube (the control) had no methylene blue, one had one drop of the dye, one had two drops, one had three drops, and the last had four drops. All five test tubes were labeled to prevent mix-ups.

I measured the light wavelength absorbance of each entire sample using a spectrophotometer and Vernier software on day 0, day 7, day 14, and day 28.

Light Wavelength Absorbance by Week

*Figure 1-4. Four graphs (one per week) of light wavelength absorbances as measured by a spectrophotometer. Each colored line corresponds to the matching color in the key to the left of the graph. The colors from bottom to top correspond to the following samples: plain seawater (always roughly at zero), control (*algae *with no methylene blue), and algae with one, two, three, and four drops respectively of the dye.*

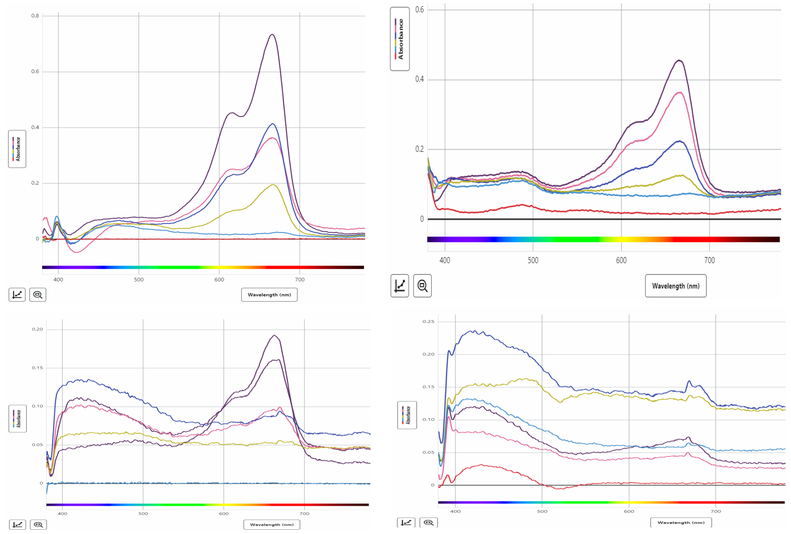
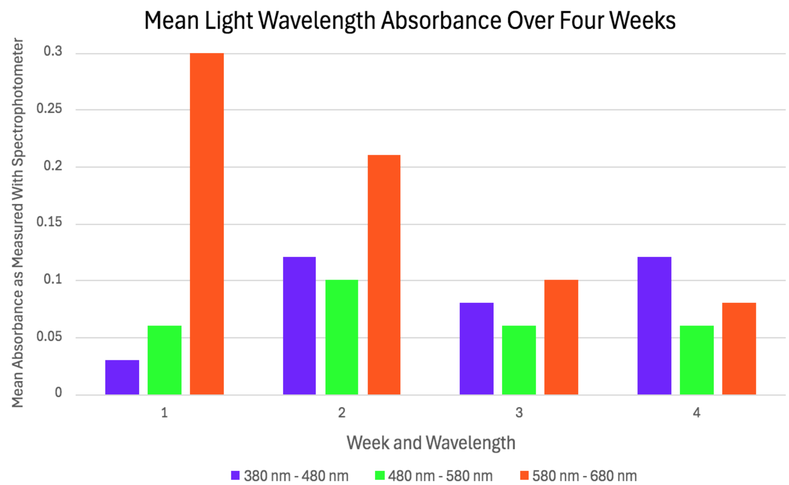


Figure 5. Bar graph showing mean absorbance of the following three ranges of wavelengths of visible light: 380-480 (blue, indigo, violet), 480-580 (green), and 580-680 (red, orange, yellow) nanometers for each week of the experiment.



Results and Discussion

Over the four weeks of my experiment, all four methylene-blue-dyed *platymonas* samples showed significant biodegradation abilities, as seen by the dramatic changes in light absorbance versus reflection. These results strongly support my hypothesis.

On the first day, all four non-control samples' absorbances were very high in the range 580-680 nm (red, orange, and yellow), fairly low from 480-580 nm (mostly green), and very low from 380-480 nm (blue and purple). The sample with four drops of dye had by far the highest peak, and the samples with less dye were less dramatic, but still showed the same characteristic shape. The control sample had no significant peaks and only dipped slightly in the green wavelength range, while the plain seawater sample was almost completely flat, absorbing negligible amounts of light. With every week that passed, all four dyed samples became visibly less blue as the methylene blue was broken down into its less harmful chemical byproducts by the *platymonas*. The spectrophotometric graphs flattened with each measurement until, after four weeks, every line resembled that of the control sample.

While I used a different species of algae than the scientists in the Science Reports article, my results were quite similar. This raises the question of whether other algaes or similar life-forms are also capable of biodegrading environmental toxins, and to what degree. With the information I have now, I could do further experiments using different types of algae on methylene blue and other environmental toxins in an attempt to mitigate the effects of toxic industrial runoff on marine ecosystems.

Acknowledgements

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Work Cited

Talha, M. A., Agua, H. E., Beltagi, A. M., El-Mohsnawy, E., Ali, A. S. (2025). Mechanistic insights into methylene blue biodegradation by *Tetradesmus Obliquus*: a multimodal approach using absorption, fluorescence, and square wave voltammetry. *Scientific Reports*, **15,** 32663.