Effects of Sunscreen on Freshwater Plants

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Abstract:

Sunscreen, though vital for skin protection, has proved to be seriously detrimental to marine sea life. According to the NOAA, chemicals leached from sunscreen into the waters can impair growth and photosynthesis in green algae, accumulate in the tissues of coral and induce bleaching and damage or kill the coral, decrease fertility in female fish, induce defects in young mussels, and effect many more organisms in similar ways[3]. This progressively throws off the marine food chain and damages the environment, leading to a collapse in ecosystem services to humanity, such as food and oxygen production, storm surge protection, and provisioning of other materials. However, research thus far has centered on coral in ocean environments with much less research regarding freshwater systems. In this project, the concentration of oxybenzone from sunscreen in freshwater systems will be studied.

Freshwater ecosystems such as Minnesota's lakes make significant contributions to the environment by replenishing groundwater and preserving biodiversity. If even one species is eliminated due to sunscreen usage, the entire hierarchy will be damaged, which could result in even more extinctions and decreased production of human benefits. This project seeks to discover how the Minnesota-native freshwater plant *Myriophyllum heterophyllum*, a water milfoil, reacts to sunscreen. We hypothesized that sunscreen with oxybenzone, the primary chemical responsible for the damage described above, will be harmful to the growth of *M. heterophyllum* by adhering to its leaves and interfering with CO_2 binding[5], and sunscreens with these chemicals in higher concentrations will have greater effects.

We grew *M. heterophyllum* in two different concentrations of two sunscreen products, one with oxybenzone and one 'eco-friendly' product without oxybenzone. Plants grown in the presence of sunscreen exhibited decreased growth which was most pronounced in the presence of the 'eco-friendly,' oxybenzone-free sunscreen rather than standard sunscreen. This suggests that sunscreen use may have negative impacts on freshwater systems comparable to those previously observed in marine systems[1].

Methods:

- *M. heterophyllum* was grown in aerated glass jars. The sprouts were first cultivated in a large aquarium, then trimmed to 3.5" and planted in 24 individual jars.
- Sunscreen samples of two different concentrations from two sunscreen products, one with oxybenzone (Coppertone) and one 'eco-friendly' product without oxybenzone (Hawaiian Tropic), were introduced into the jars and the results monitored through photography and biomass analysis.
- According to previous studies on sunscreen concentrations in coastal areas, concentrations of both 0.2mL and 0.1mL sunscreen per liter were tested[1,2].
- We allowed plants to grow for 13 days, then dried and weighed the sprouts.
- The differences in biomass were indicative of the sunscreen's effect on plant growth.

Figure 1: Set-up of experiment..

Hypothesis:

Our hypothesis that sunscreen would negatively affect plant growth was supported. However, the hypothesis that the sunscreen with oxybenzone would be more harmful than the ecofriendly sunscreen was rejected, as the plants treated with Hawaiian Tropic fared worse than the Coppertone treatments.

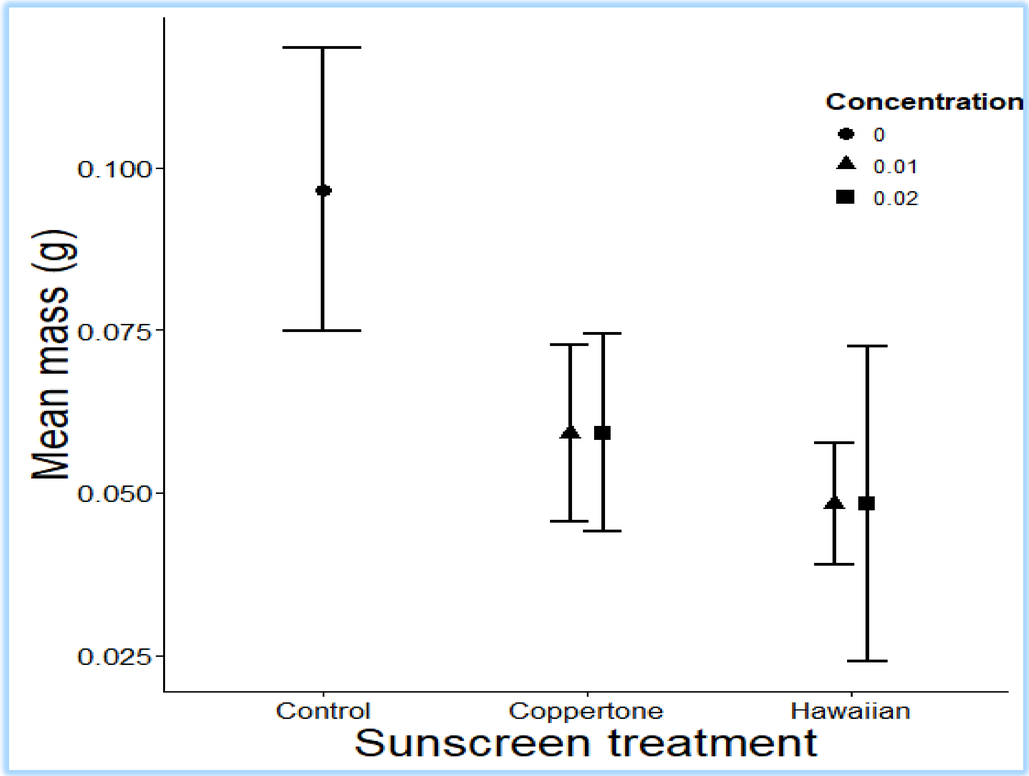

Figure 4: Sample means with 95% confidence intervals

Conclusion:

- The results of our ANOVA test showed that there was a significant difference between the control group and the sunscreen treatments.
- This research has rejected the hypothesis that sunscreen has no effect on freshwater plants.
- Sunscreen negatively affects the growth of freshwater milfoils, even in concentrations smaller than the standard concentration[1] found at beaches, 0.2 mL/L.

Figure 3: Dried plant prior to weighing. Control subject.

Results:

- ANOVA showed a significant decrease in biomass for both groups compared to the control group (Hawaiian: $T_{11} = 4.05$, $p<0.01$; Coppertone: $T_{11} = 4.98$, $p<0.01$).
- The difference in concentrations of sunscreens tested had no effect on the biomass.
- At the end of the testing period, the control group individuals showed root growth and voluminous green offshoots. The Coppertone individuals exhibited less green in offshoots and minimal root growth. The Hawaiian Tropic individuals were shriveled and had little to no root growth.

Figure 2: Left to right: Hawaiian Topic, Coppertone, and control jars.

Future Research:

- Recommendations for further research on the effects of sunscreen on freshwater plants could study the threshold at which plants begin to be affected,
- The retention of sunscreen in beaches throughout the summer swimming season,
- The effectivity of 'eco-friendly' products in regards to freshwater organisms.

References:

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[4]Wood, E. "Impacts of Sunscreen on Coral Reefs." *International Coral Reef Initiative & The Foundation for Research on Biodiversity.* (2016).

[5]Zhong, X. et. al. "Inhibition of Photosynthesis in Cucumber Leaves by Oxybenzone." *Photosynthetica*, (2019). DOI: 10.32615/ps.2019.135