Cyanocide: A Novel Strategy for Harmful Algal Bloom Mitigation via Initiation of Programmed Cell Death

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The anthropogenic release of greenhouse gases and the use of synthetic fertilizers on large-scale agricultural sites contribute to a proliferation of Harmful Algal Blooms (HABs) in many waterways, creating hypoxic "dead zones" and releasing cytotoxins detrimental to both aquatic ecosystems and human health. The objective of this project was to find an inexpensive and sustainable method of reducing cyanobacterial HABs by targeting the Thioredoxin System. The Thioredoxin System, comprised of NADPH, Thioredoxin Reductase (TrxR), and the antioxidant protein, Thioredoxin, is the main system for restoring redox equilibrium in bacterial cytosol, and, in the event of the uncontrollable growth of reactive oxygen species, is responsible for initiating programmed cell death by activating apoptotic pathways. In Phase I, TrxR inhibitors, Curcumin, Myricetin, and Parthenolide, were encapsulated in nanostructured lipid carriers (NLCs) by solvent dispersion, and a small amount was applied to each experimental group to identify the optimal inhibitor. After two weeks, spectrophotometric assays of optical density and chlorophyll along with microscopic analysis revealed that all inhibitors were able to induce cell death following a rapid increase in growth, the most effective being Curcumin. Phase II showed that an increased concentration of Curcumin and a more stable NLC emulsion led to a less prominent initial increase in growth and confirmed that the inhibitors were effective in inducing apoptosis throughout an algal colony via inhibition of TrxR. This method therefore offers an economical and environmentally responsible solution to cyanobacterial HABs by initiating and propagating programmed cell death across a live colony.

Awards Won:
First Award of $3,000