So Li?! Designing a Novel Approach for Rapid Lithium Detection: Investigating Enzymatic Coupling to Produce Hydrogen Peroxide for the Development of Colorimetric and Fluorescent Sensors and Testing the Efficacy of Horseradish Peroxidase, 3,3',5,5' Tetramethylbenzidine, and Amplex Red

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As demand for lithium ion batteries increases with the popularity of electric vehicles and other technologies, the negative effects of lithium contamination present a significant threat to the environment. Studies have shown that lithium negatively impacts soil, causing a loss of nutrients and an increase of alkalinity, hardness, and salinity, thus reducing plant growth. Due to its high mobility, lithium easily enters the food chain, and can cause toxic diseases affecting the central nervous system in humans. This project designed a method of lithium detection that is rapid, easily identifiable, and sensitive and tested colorimetric and fluorometric sensors. An enzyme coupled assay was designed involving a lithium sensitive phosphatase, producing varying amounts of hydrogen peroxide depending on the amount of lithium. Hydrogen peroxide was tested with horseradish peroxidase, along with 3,3',5,5' Tetramethylbenzidine and Amplex Red to determine the best sensor for lithium detection. A hydrogen peroxide concentration gradient by tenfold and twofold were made so the sensor would be sensitive to varying concentrations of lithium. In an initial trial, ADHP proved inadequate, remaining a barely visible pink after 18 minutes. A second trial demonstrated that the combination of horseradish peroxidase, Tetramethylbenzidine, and hydrogen peroxide resulted in an visible and sensitive color change, in varying shades of blue, that appeared after 10 seconds to a minute, depending on the hydrogen peroxide, and therefore lithium, concentration tested. Future applications will refine the correlation between color and lithium concentration, ultimately creating a kit to easily detect lithium in the environment.

Awards Won:
Air Force Research Laboratory on behalf of the United States Air Force: Glass trophy and USAF medal for each recipient
Air Force Research Laboratory on behalf of the United States Air Force: First Award of $750 in each Regeneron ISEF Category