Detection of toxicity in environmental samples using a panel of bioluminescent bacteria

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Abstract

Compared to conventional chemical methods, the bioluminescent bacterial assay is an alternative way to detect toxicity in water. Different strains of *E. coli* have been engineered to accept and reproduce plasmids containing the lux operon found in bioluminescent bacteria in the deep ocean. The lux operon was inserted in a plasmid chained with known promoters activated when normal metabolism is disturbed, further generating a measurable signal in the presence of different stressors. This method of toxicity detection is fast, cost-effective, does not require sample preparation, and has a broad detection spectrum in one run. Bacteria can also be attached to the tip of a fiber optic to create portable devices capable of screening remote places. The results show good accuracy and sensitivity for many toxicants, including heavy metals, pesticides, antibiotics, nanoparticles, and food additives. We found this method very effective for detecting heavy metal pollution, where concentrations as low as two ppb of mercury and five ppb of lead and manganese could induce significant signals. With the addition of machine learning the number of toxicants able to be detected is increased significantly and we were able to classify binary mixtures of copper and mercury corresponding to their bioluminescent kinetics and estimate their concentration in the mixture.