Aptamer-Beacon-Based Rapid Detection of Delta-9-THC for Roadside Use

Brick, Jason (School: Central York High School)

?9-tetrahydrocannabinol (THC) is among the most prevalent psychoactive drugs in the United States, with nearly 20 million users each day. Yet, detection capabilities remain limited for roadside use due to poor sensitivity, high cost, and delayed laboratory results. This study investigates a colorimetric detection platform based on a G-quadruplex-modified THC1.2. DNA aptamer coupled to a hemin-tetramethylbenzidine (TMB) system. Ultimately, this would support that extending the aptamer via a g-quadruplex would enable catalytic oxidation of TMB and improve THC-signal generation. Microplate assays were used to evaluate the effectiveness of the G-quadruplex length, hemin-TMB formulation, and THC concentration. An 18-nucleotide G-quadraplex extension produced the most distinguishable signal response under THC binding, and optimizing the TMB substrate further improved signal clarity. Under aptamer-limited conditions (50 pmol per assay), the system demonstrated reliable detection of micromolar quantities of THC per assay. These results support the feasibility of a low-cost, amplification-based aptamer assay for THC detection and provide a foundation for further sensitivity optimization and comparison to on-site detection technologies.

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