Simultaneous Electrochemical Detection of Serotonin and MicroRNAs in Biological Samples to Enhance Mental Disorder Diagnosis: Year 2

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Around the world, 15% of adolescents struggle with mental illnesses affecting mood and behavior. Depression, one of the most common conditions, is diagnosed primarily through clinical evaluation rather than objective laboratory testing. This project proposes the optimization of a novel electrochemical sensor and biosensor for detecting two mental health biomarkers: serotonin (5-HT) linked with depression, and microRNAs, whose levels vary significantly in patients with suicidal ideation (for example, miRNA-1202). The 5-HT sensor utilizes molecularly imprinted polymers (MIPs) to form a selective recognition film for serotonin. MIPs were synthesized on top of a glassy carbon electrode (GCE) where graphene oxide (GO) was drop-casted. GO was used to increase the active area of the GCE, improving the limit of detection (LOD). The 5-HT sensor's selectivity was also tested against dopamine, a neurotransmitter with similar electrochemical oxidation peaks. Conversely, a novel electrochemical biosensor was optimized for the simultaneous detection of miRNAs using the four-way-junction (4WJ) technology: a hybridization of stem-loop probe, miRNA target, and m and f strands. Furthermore, this sensor exhibited high selectivity when tested against a mismatched miRNA sequence. Biological fluids (i.e., cerebrospinal fluid and blood serum) were evaluated to mimic real-world conditions for future clinical sample analysis. Conclusively, each sensor had high reproducibility, selectivity, and sensitivity. Simultaneous detection was investigated by using different redox markers for the 4WJ biosensor. Future work involves biomarkers from pathways influenced by structural variants, known to alter gene regulation in mental disorders.

Awards Won:

Fourth Award of $600