Development of an electrochemical DNA biosensor to detect a foodborne pathogen

ABSTRACT

Vibrio parahaemolyticus (V. parahaemolyticus) is a common foodborne pathogen that contributes to a large proportion of public health problems globally, significantly affecting the rate of human mortality and morbidity. Conventional methods for the detection of V. parahaemolyticus such as culture-based methods, immunological assays, and molecular-based methods require complicated sample handling and are time-consuming, tedious, and costly. Recently, biosensors have proven to be a promising and comprehensive detection method with the advantages of fast detection, cost-effectiveness, and practicality. This research focuses on developing a rapid method of detecting V. parahaemolyticus with high selectivity and sensitivity using the principles of DNA hybridization. In the work, characterization of synthesized polylactic acid-stabilized gold nanoparticles (PLA-AuNPs) was achieved using X-ray Diffraction (XRD), Ultraviolet-visible Spectroscopy (UV-Vis), Transmission Electron Microscopy (TEM), Field-emission Scanning Electron Microscopy (FESEM), and Cyclic Voltammetry (CV). We also carried out further testing of stability, sensitivity, and reproducibility of the PLA-AuNPs. We found that the PLA-AuNPs formed a sound structure of stabilized nanoparticles in aqueous solution. We also observed that the sensitivity improved as a result of the smaller charge transfer resistance (Rct) value and an increase of active surface area (0.41 cm^2). The development of our DNA biosensor was based on modification of a screen-printed carbon electrode (SPCE) with PLA-AuNPs and using methylene blue (MB) as the redox indicator. We assessed the immobilization and hybridization events by differential pulse voltammetry (DPV). We found that complementary, non-complementary, and mismatched oligonucleotides were specifically distinguished by the fabricated biosensor. It also showed reliably sensitive detection in cross-reactivity studies against various food-borne pathogens and in the identification of V. parahaemolyticus in fresh cockles.

Keyword: Vibrio parahaemolyticus; Electrochemical DNA biosensor; Foodborne pathogen