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Abstract

The performance of the nanobiosensor for analyte detection critically depends on the shape, size, and type of the transducing material. Ongoing advances in nanoscience have made it conceivable to control the morphology and physicochemical properties of the nanomaterials that make them progressively appealing for sensing applications. The improved properties of transducer materials such as high surface area and fast electron transfer rate are being utilized to design novel and efficient electrochemical biosensors. In the last decades, electrochemical nanobiosensors have recorded great successes, but there remain some challenges of exploring the suitability of the immobilization matrix that achieve optimal bio-recognition events for food toxins.

The food toxins, Ochratoxin-A, and *Vibrio cholerae* toxin, exist in the environment, which are the reason for numerous kinds of diseases and sometimes the death of a human being. These toxins majorly spread through contaminated food products. The conventional method for the identification and detection of bacterial pathogens/toxins involves the microscopic examination techniques, which are expensive, time-consuming and need expertise. Compare to these conventional techniques; an electrochemical biosensor offers numerous advantages including instrumental ease, transportability, and moderate cost, and a powerful sensing approach.

The present research work aims to develop efficient electrochemical nanobiosensors for food toxins (Ochratoxin-A and *Vibrio cholerae* toxin) with the objectives of high sensitivity, selectivity, low cost, and easy usability. To achieve the goal of thesis, nanomaterials are synthesized using co-precipitation, hydrothermal, electrospinning, and electrodeposition methods and characterized using different techniques such as Raman spectroscopy, X-ray diffraction, scanning electron microscopy, transmission electron microscopy, X-ray

photoelectron spectroscopy, atomic force microscopy, energy dispersive X-ray spectroscopy, Fourier transform Infrared spectroscopy, zeta potential measurement, UV-visible spectroscopy, fluorescence spectroscopy, contact angle, and electrochemical measurements.

The immunosensors for Ochratoxin-A detection have been designed based on modified Zirconia nanoparticles (ZrO_2 NPs). Two types of strategies are used to obtain a modified zirconia-based electrode. In the first strategy, metal (Al) is doped in ZrO_2 lattice to achieve stabilized ZrO_2 with enhanced ionic conductivity, electrochemical behavior, surface charge, surface to volume ratio, and adsorption capability. In the second strategy, ZrO_2 based nanocomposites are formed with different carbon variants such as aminated carbon, reduced graphene oxide, and graphene quantum dots. These nanocomposites have offered advantages of minimized the aggregation of NPs, enhanced the electrochemical properties, surface area, hydrophilicity, fast electron transfer, and provide desired functional groups. Such features of modified ZrO_2 NPs have made it uniquely qualified for meeting the demands for the development of efficient electrochemical biosensors for Ochratoxin- A detection.

Beside this, electrochemical nanobiosensors for sensitive and selective detection of *Vibrio Cholerae* toxin have been fabricated using electrospun polyacrylonitrile nanofibers and electrodeposited porous ZnO thin film. These nanostructures have offered advantages of large surface area, high catalytic efficiency, mechanical stability, strong adsorption ability, and rich surface chemistry.