Electrochemical sensory detection of Sus scrofa mtDNA for food adulteration using hybrid Ferrocenylnaphthalene Diimide intercalator as hybridization indicator

ABSTRACT

In this study, an electrochemical DNA biosensor was developed based on the fabrication of silicon nanowires/platinum nanoparticles (SiNWs/PtNPs) on a screen-printed carbon electrode (SPCE) for the detection of Sus scrofa mitochondrial DNA (mtDNA) in food utilizing a new hybrid indicator, ferrocenylnaphthalene diimide (FND). The morphology and elemental composition of the SiNWs/PtNPs-modified SPCE was analyzed by field emission scanning electron microscopy (FESEM) combined with energy dispersive X-ray spectroscopy (EDX). Cyclic voltammetry (CV) was used to study the electrical contact between the PtNPs and the screen-printed working electrode through SiNWs, while electrochemical impedance spectroscopy (EIS) was used to measure the charge transfer resistance of the modified electrode. The results clearly showed that the SiNWs/PtNPs were successfully coated onto the electrode and the effective surface area for the SiNWs/PtNPs-modified SPCE was increased 16.8 times as compared with that of the bare SPCE. Differential pulse voltammetry used for the detection of porcine DNA with FND as an intercalator confirmed its specific binding to the double-stranded DNA (dsDNA) sequences. The developed biosensor showed a selective response towards complementary target DNA and was able to distinguish non-complementary and mismatched DNA oligonucleotides. The SiNWs/PtNPs-modified SPCE that was fortified with DNA hybridization demonstrated good linearity in the range of $3 \times 10{-}9$ M to $3 \times 10{-}5$ M ($R2 = 0.96$) with a detection limit of $2.4 \times 10{-}9$ M. A cross-reactivity study against various types of meat and processed food showed good reliability for porcine samples.