The Fabrication of an Impedance Immunosensor Based on Interdigitated Array Microelectrodes and Normalized Impedance Changes for Chlorpyrifos Residue Detection

Wenping Zhao^{1,2*}, Yemin Guo^{1,2}, Qingxue Zhao^{1,2}, Jianfei Sun^{1,2}, Zhiqiang Wang^{2,3}, Xia Sun^{1,2*}

¹ School of Agriculture Engineering and Food Science, Shandong University of Technology, No. 12 Zhangzhou Road, Zibo 255049, Shandong Province, P.R. China

² Shandong Provincial Engineering Research Center of Vegetable Safety and Quality Traceability, No. 12 Zhangzhou Road, Zibo 255049, Shandong Province, P.R. China

³ College of Computer Science and Technology, Shandong University of Technology, No. 12 Zhangzhou Road, Zibo 255049, Shandong Province, P.R. China

*E-mail: 187286528@qq.com, sunxia2151@sina.com

doi: 10.20964/2020.01.11

Received: 21 June 2019 / Accepted: 16 October 2019 / Published: 30 November 2019

A novel impedance immunosensor was developed based on antibodies fixed on interdigitated array microelectrodes (IDAMs) to detect chlorpyrifos residues. Before use, IDAMs were cleaned using the best method among three methods. Anti-chlorpyrifos monoclonal antibodies were oriented on IDAM surfaces by staphylococcal protein A (SPA). SPA was immobilized on the microelectrode surfaces to provide a better interface for biocompatibility and to increase a fixed amount of antibodies. The immobilized antibodies captured target chlorpyrifos and changed the impedance of the IDAM surface. Electrochemical impedance spectroscopy (EIS) was then used to characterize the change. According to the test results, the best volumes and concentrations of SPA, anti-chlorpyrifos antibodies and BSA drops on IDAMs, as well as the volume and pH of the working buffer used in the experiments were determined. Under the optimal conditions, the correlation between impedance signals and the chlorpyrifos concentration of the incubated electrochemical biosensor was studied. To deal with measured data using normalized impedance and analyze the correlation of two concentrations (1 µg/mL and 10 µg/mL) of chlorpyrifos with impedance signals at seven specific frequencies (1 Hz, 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz and 1 MHz), the optimal frequency (100 Hz) was selected. The standard curve was drawn after extracting the impedance values under different concentrations of pesticides at the frequency of 100 Hz. To determine the normalized impedance change (NIC) at 100 Hz against the logarithm from 1 ng/mL to 100 µg/mL of the chlorpyrifos concentration (LgC), the used regression equation was $y = 132.62x + 733.1$, with a linear correlation coefficient of 0.9946. The lowest limit of detection (LOD) for this biosensor was 1 ng/mL. The immunosensor showed good specificity and sensitivity for chlorpyrifos detection.

Keywords: Immunosensor; Chlorpyrifos; Interdigitated array microelectrode; Normalization

[FULL TEXT](#)

© 2020 The Authors. Published by ESG (www.electrochemsci.org). This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution license (<http://creativecommons.org/licenses/by/4.0/>).