Label-free Lectin Impedimetric Biosensor Based on a Polyaniline/Graphene Nanocomposite for the Detection of *Escherichia coli*

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This work reports a label-free impedimetric biosensor based on a polyaniline (PANI) and graphene (G) composite on a glassy carbon electrode (GCE) for the detection of *Escherichia coli* (*E. coli*) with lectin as the recognition molecule. The PANI/G nanocomposite was synthesized by in situ electrochemical oxidative polymerization of aniline onto G and Nafion. The effect of the polymerization on the electron performance of the sensing surface was checked. The results indicated that the heterogeneous electron transfer rate increased from $4.30 \times 10^{-4} \text{ cm s}^{-1}$ to $4.70 \times 10^{-4} \text{ cm s}^{-1}$ after the incorporation of PANI onto the G/Nafion/GCE with ferrous/ferric as the redox probe. The lectin of *Concanavalin A* (Con A) was used to recognize the carbohydrate moiety on the surface of *E. coli*, which demonstrated the recognition ability of the synthesis interface. The DH5 α *E. coli* bacteria strain was chosen as a model target. When the biosensor was incubated with the target under optimized experimental conditions, the electron transfer resistance (R_{et}) increased when the *E. coli* concentration increased from 5.0×10^1 cells/mL to 1.0×10^4 cells/mL. The detection limit for the biosensor was calculated to be 43 cells/mL based on a signal-to-noise ratio of 3. The biosensor was also challenged by incubation with two different bacteria without Con A binding sites, which showed negligible changes in the R_{et} value. The hybrid PANI and G nanocomposite enables us to enhance the biosensor response and reproducibility without sacrificing the electrical conductivity, as found for the use of additives. The developed biosensor highlights a promising approach for the sensitive determination of other desired bacteria via incorporation with a nanocomposite.

Keywords: impedimetric biosensor; electrochemical polymerization, polyaniline and graphene; lectin; *Escherichia coli*

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