Development and Evaluation of Surface-Enhanced Raman Spectroscopy (SERS) Filter Paper Substrates Coated with Antibacterial Silver Nanoparticles for the Identification of Trace *Escherichia coli*

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Abstract

In this work, a sensitive and reasonably priced surface-enhanced Raman spectroscopy (SERS)-based biosensor is developed for the quick identification of *Escherichia coli* (*E. coli*), a key marker of fecal contamination in food and water. A filter paper (FP) substrate coated with silver nanoparticles (AgNPs), which were produced by a straightforward chemical reduction method, was used for developing the biosensor. After the AgNPs were carefully examined, it was discovered that they produced active plasmonic sites on the FP substrate, which made it possible to detect the molecular vibrations of *E. coli*. The remarkable sensitivity of the SERS-based FP-AgNP biosensor was shown by its ability to detect very low concentrations of *E. coli*, as low as 10 colony-forming units (CFU)/mL. The AgNPs also shown antimicrobial properties. The substrates' repeatability was verified by experimental Raman measurements, and the enhancement factor for identifying the molecular vibrations of *E. coli* was determined to be 2.197×10^5 based on empirical calculations and 4.587×10^5 based on numerical estimations. These findings demonstrate how well the proposed SERS-based biosensor works for the quick and accurate detection of *E. coli*, which is essential for guaranteeing the safety of food and water. The results of the research open the door to the development of sophisticated SERS-based monitoring and detection systems with the additional benefits of being inexpensive, straightforward, adaptable, and chemically stable for a range of uses in environmental protection and public health.