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Rapid detection of amoxicillin in an aqueous medium by Surface-Enhanced Raman Spectroscopy

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Background: Antibiotics are becoming less effective, forming antibiotic-resistant bacteria, which has led to the emergence of superbugs due to excessive usage in recent years. Since antibiotic pollution is a severe public health problem in the 21st century, detecting trace antibiotic residues in an aqueous medium has become a critical requirement. Amoxicillin (AMX) belongs to the beta-lactam group of antibiotics. Although various methods are available, developing a simple, cost-effective, label-free, and ultrasensitive approach would help limit pre-detection exposure.

Objective: To develop a novel, simple method for rapidly detecting amoxicillin in an aqueous medium based on Surface-Enhanced Raman Spectroscopy (SERS).

Methods & Materials: Silver nanoparticles which, were prepared using Leopold and Lendl method, were characterized by Thermo-Scientific GENESYS 10S UV-Vis spectrometer and Visionlite software. SERS spectra were obtained to optimize the method by fluctuating the nanoparticles to amoxicillin ratio and aggregating agents (MgSO4 and NaCl). Concentration series of AMX was prepared as 5 ppm, 2.5 ppm, 0.5 ppm, 0.25 ppm, 0.05 ppm, 0.025 ppm, 0.005 ppm and SERS spectrum for each solution were obtained using 1:1 (AMX:Ag) v/v ratio with 20 ml of 1.0 mol/dm^3 solution of $MgSO_4$. The Raman spectra were obtained using Thermo scientific DXR 2 Raman spectrometer at an excitation wavelength of 785 nm and a laser power of 50 mW.

Results: According to the results of UV analysis, the maximum wavelength was 414 nm for synthesized silver nanoparticles. $MgSO_4$ was the only salt that could enhance the Raman intensity concerning NaCl, and 1:1 (AMX:Ag) v/v ratio with 20 mL of 1.0 mol/dm^3 solution of $MgSO_4$ gave the best peak enhancement.

Conclusion: This study provides a fast and straightforward approach to detect amoxicillin residues over 5 ppb concentration in an aqueous medium using SERS along with magnesium sulfate. However, with further optimizations, this could serve as a rapid and straightforward novel technique in the ultra-low detection of amoxicillin in various aquatic resources.