K10 The Application of Gold Nanoparticles for the Trace Detection of PINACAs in Urine by Surface Enhanced Raman Spectroscopy (SERS)

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After attending this presentation, attendees will understand the principles of SERS, how SERS can be used to create a low limit of detection for synthetic cannabinoids, the effect of using different aggregating agents when combined with gold nanoparticles to enhance the limit of detection, and how SERS can be a fast and easy analysis for drug detection in toxicological samples.

This presentation will impact the forensic science community by demonstrating the application of SERS as a useful procedure of detecting trace levels of synthetic cannabinoids in solution that is rapid, sensitive, and applicable to a variety of biological matrices.

The use and abuse of synthetic cannabinoids has increased significantly in recent years due to their easy access and growing popularity in young adults. Initially, these drugs, known as "Spice" or "K2," were sold in retail outlets or via the internet and labeled as "not for human consumption" to avoid any possible regulation of the products by the Food and Drug Administration. This popularity has led to an increase in emergency room visits due to synthetic cannabinoid intoxication in recent years. As more of these drugs become illegal, new synthetic legal versions of these drugs are being made, which presents problems for the forensic scientist as standard methods may not detect the target drug.

The most common method of screening detection for drugs of abuse in biological samples is the immunoassay; however, this method presents some disadvantages, particularly for newly synthesized compounds which may not respond to the test. Other problems include cross-reactivity between different synthetic cannabinoids, hook effects, and high cut-off values for determining if the drug is present. More advanced methods have also been used, such as Gas Chromatography/Mass Spectrometry (GC/MS); however, these procedures involve complex sample preparation and long run times. A potential solution to this issue is SERS.

Raman spectroscopy is an under-utilized technique for the detection and identification of drugs due to its perceived low sensitivity for analytes in solution using traditional procedures; however, when Raman spectroscopy is performed in the presence of metallic nanoparticles, signal can be enhanced several orders of magnitude, and this is known as SERS. The addition of aggregating agents, generally ionic salts, further increases the signal via the creation of hot-spots due to displacement of the stabilizing agent which leads to a change in the surface of the metallic nanoparticle and the ionic strength of the solution. This method has already been confirmed to work for the toxicological detection of benzodiazepines with limits of detection ranging from 1ng/mL to 200ng/mL.

In this project, gold nanoparticles were prepared using a sodium citrate reduction and aggregating agents were used to enhance the Raman signal of four different synthetic cannabinoids: APINACA (AKB48), AB-PINACA, ADB-PINACA, and AB-CHMINACA, and their metabolites. Seven different aggregating agents including MgCl2, CaCl2, KCl, NaCl, MgSO4, KNO3, and Na2SO4 were examined at varying concentrations to optimize sensitivity of detection. Once optimized, the SERS method was used to analyze spiked urine samples containing the parent drug and metabolites. Other factors, including the concentration of nanoparticles, time, and temperature, were also examined. Upon analysis, the Raman spectrum of each synthetic cannabinoid could be easily distinguished and mixture resolution was possible using the KnowItAll® computer software program.

These results demonstrate that SERS can be utilized to detect trace amounts of PINACAs and their metabolites in aqueous solutions. Therefore, following rapid extraction of the analyte, SERS can be used as a detection method of synthetic cannabinoids in urine and saliva samples, which can be useful in forensic toxicology laboratories.

SERS, PINACAs, Toxicology

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