K39 Surface-Enhanced Raman Analysis of Synthetic Cannabinoids Using Gold Nanoparticles and Various Aggregating Agents

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After attending this presentation, attendees will understand the principles of Surface-Enhanced Raman Spectroscopy (SERS), how SERS can be used to lower the limit of detection of 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 for 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 lead 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. This presents problems for the hospitals and the forensic investigator 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. 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 Raman spectroscopy. This procedure 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, which is known as SERS. The addition of aggregating agents, generally ionic salts, further increase the signal via the creation of hot-spots due to displacement of the stabilizing agent which leads to a change in the surface change 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-200ng/mL and for THC with limits of detection less than 10ng/mL. In addition, this method can be made portable and used for on-site detection allowing for a faster analysis time.

In this project, gold nanoparticles were prepared using a sodium citrate, hydroxylamine, or borohydrate reduction and aggregating agents were used to enhance the Raman signal of five different synthetic cannabinoids: JWH-018, JWH-073, JWH-081, JWH-122, and JWH-250. Seven different aggregating agents including MgCl2, CaCl2, KCl, NaCl, MgSO4, KNO3, and Na2SO4 were examined at varying concentrations to optimize sensitivity of detection. Other factors, including the concentration of nanoparticles and time and temperature, were also examined. Upon analysis, the Raman spectrum of each synthetic cannabinoid could be easily distinguished when compared to the Raman signal of the powder form of the drug. Nanogram-per-milliliter concentrations can be detected of each synthetic cannabinoid.

These results demonstrate that SERS can be utilized to detect trace amounts of synthetic cannabinoids in aqueous solutions. Therefore, following the extraction of the analyte, SERS can be used as a detection method of synthetic cannabinoids in toxicological samples, which can be useful in a hospital setting, workplace drug testing, and in forensic toxicology laboratories.

SERS, Synthetic Cannabinoids, Toxicology

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