B212 Implementing Raman Spectroscopy as a Tool to Characterize Sexual Assault Lubricants

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Learning Overview: This project is an extension of the National Center for Forensic Science Sexual Assault (NCFS SAL) database. The database provides analytical data of sexual lubricants obtained from Direct Analysis in Real Time-Time-of-Flight/Mass Spectrometer (DART®-TOF/MS), Gas Chromatography/Mass Spectrometer (GC/MS), and Fourier Transform Infrared Spectroscopy (FTIR). After attending this presentation, attendees will understand the significance of Raman spectroscopy for screening sexual assault lubricants and its ability to classify unknown lubricants.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing a supplemental method to identify trace lubricant residue based on its distinct "chemical fingerprints."

More than 10 % of sexual assault cases reported involve condom use. In these instances, the chance of retrieving DNA evidence becomes minimal, and, therefore, other pertinent evidence, such as trace lubricant, can assist with justification. Previous research of the NCFS lab demonstrates the confidence of identifying and classifying trace lubricant based on its chemical constituents. Protocols were established using DART®-MS, GC/MS, and FTIR to distinctly associate various types of lubricants produced by multiple manufacturers. Further investigation elaborates on the ability to use chemical components as a bias to confidently classify lubricants into distinctive groups (e.g., flavored water-based, anesthetic water-based).

Raman spectroscopy provides molecular identification based on inelastic scattering from a monochromatic light (laser source). The change in frequency of a photon after interacting with the sample defines Raman scattering. Raman spectroscopy is non-destructive, highly sensitive, and reproducible with the appropriate parameters. These advantages appeal to forensic labs, which increases its use in identifying trace evidence, including textile fibers, paint, polymers, pigments and dyes, cosmetics, and explosives. Raman spectroscopy has presented itself as a useful tool in criminalistics, especially in the analysis of polymers, such as lubricants. Therefore, expanding the SAL database with spectral analysis of lubricants using Raman spectroscopy can prove beneficial.

Fifty samples inclusive of 21 Personal Hygiene Products (PHPs), 12 bottled lubricants, and 17 condoms were analyzed using Raman spectroscopy. The PHPs included body washes and soaps, whereas the lubricants were representative of two types: water-based and oil-based. Spectra were obtained on neat lubricants and extracts in triplicates via Raman spectroscopy with a laser beam at 785nm. Statistical analyses were performed using Principal Component Analysis (PCA), Hierarchical Cluster Analysis (HCA), and Linear Discriminant Analysis (LDA) to classify the samples into groups based on shared components. After assessment of the neat samples, ten groups were established with 10% similarity based on the HCA dendrogram. Most of the samples clustered into groups could be identified by their obvious classes (lubricants vs. personal hygiene products); however, overlap was found, which will be discussed in the presentation.

Raman Spectroscopy, Lubricants, Personal Hygeine Products

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