



B93 The Persistence and Environmental Degradation Patterns of Sexual Lubricants and Personal Hygiene Products (PHPs) Using Direct Analysis in Real-Time Time-Of-Flight/Mass Spectrometry (DART®-TOF/MS) and Gas Chromatography/Mass Spectrometry (GC/MS)

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After attending this presentation, attendees will be able to visualize the degradation profiles of lubricants and PHPs under various environmental conditions and time periods. The discriminating capabilities of DART®-TOF/MS and GC/MS will also be demonstrated. Each technique will be evaluated through statistical treatments such as Hierarchical Cluster Analysis (HCA), Principal Component Analysis (PCA), and Linear Discriminant Analysis (LDA).

This presentation will impact the forensic scientific community by introducing a framework in which sexual assault evidence can be analyzed given trace amounts and degraded samples on fabric matrices.

Recently, condoms have been used to conceal DNA evidence gathered from seminal fluid, thereby bypassing conviction of the perpetrator. As a result, sexual lubricants have been considered as trace evidence in sexual assault crimes; however, the residuals from lubricants tend to resemble that of personal hygiene products, which may give rise to false positives in analysis. In a recent study in which the neat form of lubricants and PHPs were analyzed using DART®-TOF/MS, a statistical distinction between lubricants and PHPs was demonstrated.¹ With this research, a protocol in which both sample groups are distinguished can be utilized in sexual assault cases. Furthermore, a way to be able to trace a degraded profile back to the neat lubricant profile is required as the delayed reports of the assault are likely, thus resulting in degraded or trace amounts of residuals collected from the victim versus the neat, unaltered profile. The purpose of this study was to analyze the degradation profiles of lubricants and personal hygiene products over time.

The samples were analyzed using two techniques, DART®-TOF/MS and GC/MS. GC/MS will be utilized in the analysis of samples to illustrate how degraded samples change over time; however, co-elution issues and the inability to analyze silicone-based samples without prior sample extraction or pyrolysis makes it difficult to develop a single simplistic method for the analysis of sexual lubricants. Conversely, DART®-TOF/MS is an ionization technique that employs a heated, excited gas stream to ionize the sample in an ambient atmosphere in either positive or negative modes. The lack of chromatographic separation allows for the analysis of silicone-based lubricants in addition to the other marketing types. Additionally, no sample preparation is generally required for analysis and real-time, high-resolution mass spectra are produced.

Thirty-two samples consisting of 12 bottled lubricants, 10 PHPs, and 10 condoms were analyzed and subsequently degraded. For this study, both persistence over specified time intervals, (0, 3, 6, 9, 12, 16, 24, 48, and 72 hours) and induced environmental conditions were evaluated. To determine the environmental and persistence effects on the degradation of the lubricants, .25g of each lubricant was deposited and rubbed into common fabrics (e.g., underwear and bedding). Samples were exposed to different environmental conditions, then analyzed to determine how the chemical composition of major and minor components changed over a three-day period, thereby identifying the persistence of the specific components after use. Each lubricant sample was exposed to the following situations in an indoor environment: cold temperature (5°C), room temperature (22°C), and hot temperature (39°C) under the specified exposure times with and without direct Ultraviolet (UV) exposure.

Following sample analysis, chemometric methods were applied to the dataset and compared against the neat dataset of both lubricants and PHPs. Using HCA and PCA, a clear distinction between lubricants and PHP samples was observed, with correlation decreasing with prolonged exposure to degradation conditions. The degraded profiles of lubricants and PHPs were found to be statistically different using significant peak classifiers as discriminating factors. LDA was used to compare the degraded samples against the neat dataset to evaluate if the classifications from degraded profiles would provide similar groupings, displaying the relationship of neat and degraded samples alike.

The goal of this study was to evaluate the degraded profiles of lubricants and personal hygiene products over time under induced environmental conditions. Additionally, a method in differentiating the neat and degraded profiles of both lubricants and PHPs was developed. The ultimate goal is to create a protocol in which lubricants and PHPs (in their neat and degraded forms) can be examined as common pieces of evidence in sexual assault cases.

Reference(s):

1. Yasmine Moustafa, Candice M. Bridge. Distinguishing sexual lubricants from personal hygiene products for sexual assault cases. *Forensic Chemistry*. 5 (2017) 58-71.

DART®-TOF/MS, Lubricant Degradation, Extraction Process