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Forensic Analysis of Accelerant (Aerosol Spray) on Different Fabrics using Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR) and Chemometrics Technique

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Structured Abstract

Background: Forensic investigation of fire and arson often involve analysis of accelerant and fire debris to determine the cause of fire. Common accelerant used in arson cases include petrol, kerosene and diesel. Aerosol sprays is well known for their significant flammability due to the presence of volatile organic compounds (VOCs) such as propane, butane, and dimethyl ether. While arson cases involving the use of aerosol is scarce, this crime still happens. Traditional forensic procedures such as Gas Chromatography-Mass Spectrometry (GC-MS) are frequently used to evaluate such accelerants. This study explored the potential of ATR-FTIR spectroscopy, which is non-destructive, fast, and environmentally friendly technique. This study aims to analyse the burnt residues from fabrics sprayed with aerosol accelerant and determination of fabric residues using Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR) coupled with chemometrics techniques.

Methods: Fabrics (cotton, linen, polyester and rayon) were cut into 30x30cm size and burned using lighter as ignition source while spraying the aerosol products (Gatsby Pomade Spray, Gatsby Deodorant spray, Aeropark choke cleaner and Baygon Cockroach Control) for 10 seconds and left to burn completely. The residues were then collected and analysed using ATR-FTIR with predetermined settings and the resultant IR results; were analysed for principal component analysis (PCA).

Results: Results showed that ATR-FTIR spectra revealed the presence of multiple functional groups such as alcohols, alkanes, ketones, anhydrides, ethers, and aromatic compounds in the aerosol sprays. The study identified distinct chemical transformations in the fabrics post-burning, including the formation of nitriles, alkynes, and aromatic compounds. The PCA demonstrated 98.62% and 97.77% of variance for fabrics burned using Gatsby Deodorant spray and polyester burned using all spray respectively. ATR-FTIR with PCA was unsuccessful in determining aerosol used in burned fabric. This method combination however was successful in clustering the type of burned fabrics when sprayed with Gatsby Deodorant spray.

Conclusion: ATR-FTIR spectroscopy coupled with chemometric techniques had enabled the identification of the functional groups for fabrics, as well as statistically supported by discrimination of the different fabrics. This method offers alternative to traditional forensic procedures like GC-MS, highlighting its potential in forensic investigations of fire and arson involving aerosol sprays.

Keywords: Aerosol spray, Arson, Chemometrics techniques, ATR-FTIR spectroscopy

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