



### D29 Analysis of the Organic Composition of Gunshot Residue

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The goal of this presentation is to demonstrate the analysis of the organic composition of gunshot residues by LC-MS/MS and to determine if the residue produced by particular ammunition is unique to its manufacturer.

This presentation will impact the forensic science community by providing an analysis method for the organic composition of gunshot residues and by exhibiting a comparison of the organic compositions to be used as a tool by forensic investigators to discriminate between manufacturers of ammunitions.

Gunshot residue can be defined as the particles expelled from a firearm upon its use and can be deposited on the skin or clothing of both the shooter and the victim. The residues are generally composed of inorganic particulates from the primers and organic particulates from the propellant powders used in the firearm's ammunition. Traditional gunshot residue analysis entails the determination of the presence of particles containing lead, barium, and antimony using SEM/EDX. Due to safety concerns, however, many manufacturers are no longer using lead in the production of their ammunitions. Previous methods analyzing the inorganic composition of gunshot residues are therefore no longer as valuable in forensic investigations.

Analysis of gunshot residues by liquid chromatography tandem mass spectrometry provided both qualitative and quantitative data on the organic compositions of the residues. This research is presented as an alternative to the traditional inorganic methods previously used and as a means of comparing residue compositions. Certain organic components of propellant powders, such as nitrocellulose and nitroglycerine, are commonly used in the manufacturing of other products, and as such were not analyzed. The seven organic compounds primarily studied in this research are explicitly indicative of gunshot residue: ethyl centralite, methyl centralite, akardite II, diphenylamine, N-nitrosodiphenylamine, 4-nitrodiphenylamine, and 2-nitrodiphenylamine.

Initially, standards of each of these compounds were analyzed, both separately and as a mixture, to optimize the liquid chromatography and mass spectrometer parameters. Gunshot residues produced from several different ammunitions were then collected on fabrics and extracted before being analyzed under these optimal conditions. A solid-phase extraction technique was utilized with C-18 cartridges to concentrate the residue samples. A multiple reaction monitoring (MRM) method was used to discriminate between the parent and daughter ions of each compound for increased sensitivity. All samples and standards were prepared and processed with a combination of acetonitrile, methanol, and water, and were ionized by the mass spectrometer via positive electrospray ionization. Gunshot residue samples were also subjected to Quadrupole Time-of-Flight mass spectrometry to qualitatively identify any additional significant organic compounds.

Various gunshot residues were analyzed to determine if this method is reliable for use in forensic investigations to positively identify a substance as gunshot residue. The organic composition of each residue was evaluated to establish variations between manufacturers of ammunitions. Any significant deviations in composition would allow investigators to identify the manufacturer of an ammunition that produced a particular sample of gunshot residue. Following Locard's principle, the ability to identify the manufacturer of ammunition from gunshot residues can further assist investigators by linking possible suspects to the scene or by eliminating potential suspects.

#### **Gunshot Residue, Organic, Mass Spectrometry**