B150 The Analysis of Black Powder Substitutes Containing Ascorbic Acid by Ion Chromatography- Mass Spectrometry (IC-MS)

Gui-hua L. Lang, PhD, and Katherine M. Boyle, MFS, Bureau of Alcohol, Tobacco, and Firearms, 6000 Ammendale Road, Ammendale, MD 20705*

After attending this presentation, the attendee will have learned different methods for analyzing black powder substitutes containing ascorbic acid (AA) by IC-MS.

This presentation will impact the forensic community by demonstrating a more direct and sensitive method for analyzing trace levels of black powder substitutes containing AA, including post-blast residues from pipe bomb fragments.

Every year the ATF forensic science laboratories examine evidence from numerous improvised explosive devices (IEDs), the majority of which are filled with propellants such as smokeless powder, black powder, and black powder substitutes. The current trend among black powder substitutes is the utilization of organic acids as a replacement fuel for sulfur. Ascorbic acid, commonly known as Vitamin C, is one such organic acid that is currently being used in several black powder substitute formulations, such as American Pioneer Powder, Jim Shockey's Gold, and Goex Pinnacle Replica black powder. While Hodgdon Pyrodex continues to be the most commonly encountered black powder substitute in ATF's explosive casework, these ascorbic acid powders are starting to appear in casework more often.

The rapid degradation of ascorbic acid is a well-documented phenomenon that complicates the identification of these black powder substitutes, especially in post-blast devices. Although recent Liquid Chromatography-Mass Spectrometry (LC-MS) and Gas Chromatography-Mass Spectrometry (GC-MS) methods have been successful in identifying ascorbic acid and/or its degradation products in intact powders, a method sensitive enough to identify ascorbic acid in post-blast residue has yet to be reported. Here, a more sensitive and direct IC-MS method of analyzing ascorbic acid through its degradation products is presented. Water extracts of both intact powder and post- blast pipe bomb fragments were analyzed by IC-MS. Although the organic fuel (ascorbic acid) is not detected in its original form by this IC- MS method, three diagnostic degradation products of ascorbic acid can be identified in the intact powders: oxalate (m/z 89), threonate (m/z 135), and monohydrated diketogulonate (m/z 209). Oxalate and trace levels of additional as yet unidentified ascorbic acid degradation products were detected in post-blast residues. The full anion profile for the intact powders consisted of NO_3 , oxalate, threonate, monohydrated diketogulonate, and ClO_4 (for those powders with a $KClO_4$ oxidizer). distinguishing difference in similar components that ATR may not be The full anion profile for the two post-blast powders analyzed contained able to distinguish. a large amount C_{l-}, and lower levels of ClO_4 , ClO_3 , NO_3 , NO_2 , HCO_3 and oxalate. The monohydrated diketogulonate and threonate could only be identified in some of the post-blast samples. It is important to consider that the identification of post-blast ascorbic acid black powder substitutes should be based on the complete anion profile, not merely the presence of the oxalate anion, for example. The presence of other ions, such as chloride, nitrate, perchlorate and bicarbonate, in addition to the lack of sulfur-containing ions are all key components of the anion profile.

Black Powder Substitutes, Ion Chromatography-Mass Spectrometry (IC-MS), Ascorbic Acid

 ** Presenting Author*