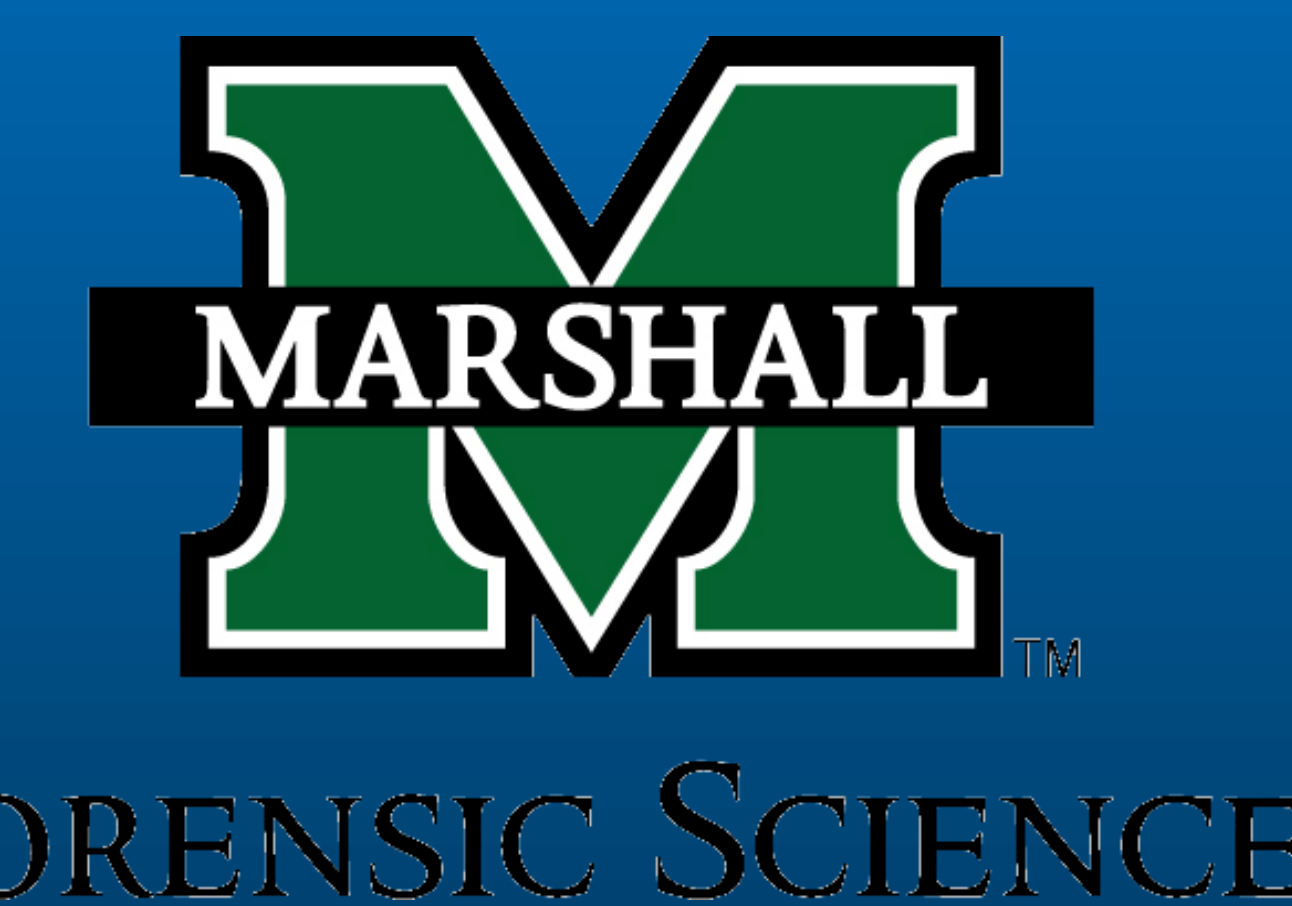




Detection of methylenedioxypropylamphetamine (MDPV), 4-methylmethcathinone (mephedrone), and 4-methoxymethcathinone (methedrone) by gas chromatography-chemical ionization tandem mass spectrometry



Lindsey E. Hume^{1*}, BS, Randall D. Fornshell², BS, Timothy P. Rohrig², PhD, J. Graham Rankin¹, PhD

¹ Marshall University Forensic Science Center, 1401 Forensic Science Drive, Huntington, WV 25701

² Sedgwick County Regional Forensic Science Center, 1109 N. Minneapolis, Wichita, KS 67214

ABSTRACT

Bath salts have recently gained popularity among recreational drug users. Thus, bans are beginning to occur for the compounds commonly found in the products. The determination and development of the most suitable method for the identification of common bath salts ingredients mephedrone, methedrone, and MDPV using gas chromatography-mass spectrometry was achieved.

Samples were analyzed on a Varian 8400 GC coupled to a Varian 1200 MS capable of single and triple quadrupole analysis in electron ionization or chemical ionization mode. Chromatograms and mass spectra were obtained in EI GC-MS, EI GC-MS/MS, CI GC-MS, and CI GC-MS/MS modes, then compared to determine the most definitive results. Triple quadrupole analysis was performed as a full scan or multiple reaction monitoring. CI GC-MS/MS analysis in MRM mode sufficiently characterized the studied compounds.

In order to accommodate the nature of rapidly-evolving designer drugs, this method is designed to incorporate new compounds as they are introduced on the market.

INTRODUCTION

As of July 2011, U.S. poison control centers have received 3,740 exposure reports for the year, compared to only 303 calls in 2010 regarding synthetic cathinones. This outbreak has led many states to control or ban many of the synthetic cathinones. Kansas is one such state, and the synthetic cathinones have been controlled as a class of compounds. Through this legislation, MDPV, mephedrone, and methedrone, among others, have been banned.

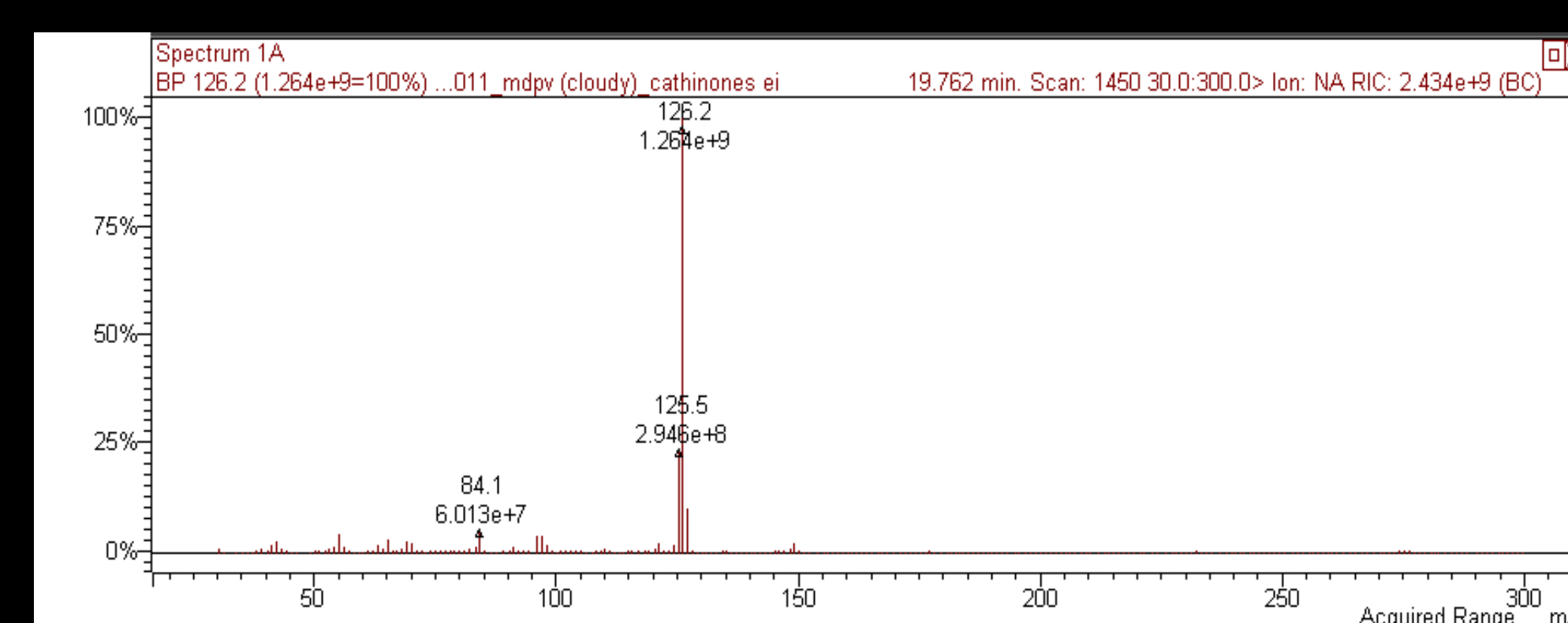
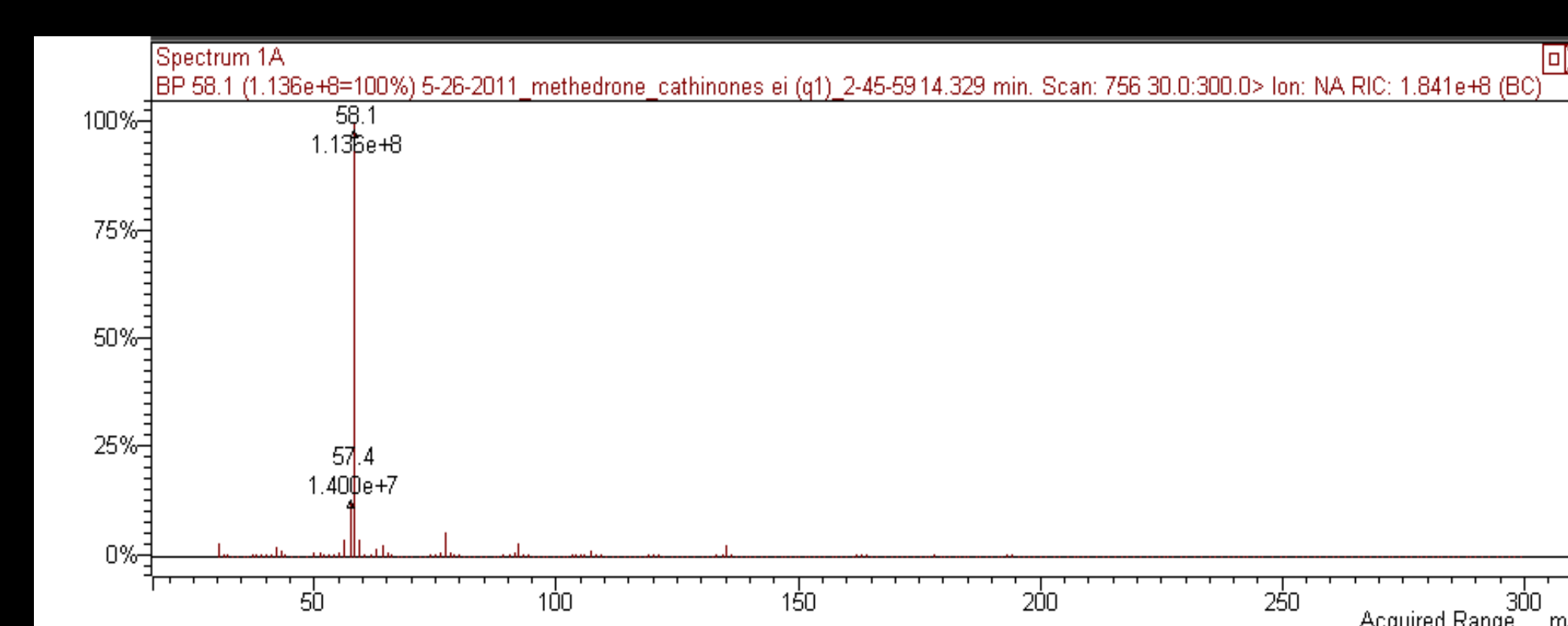
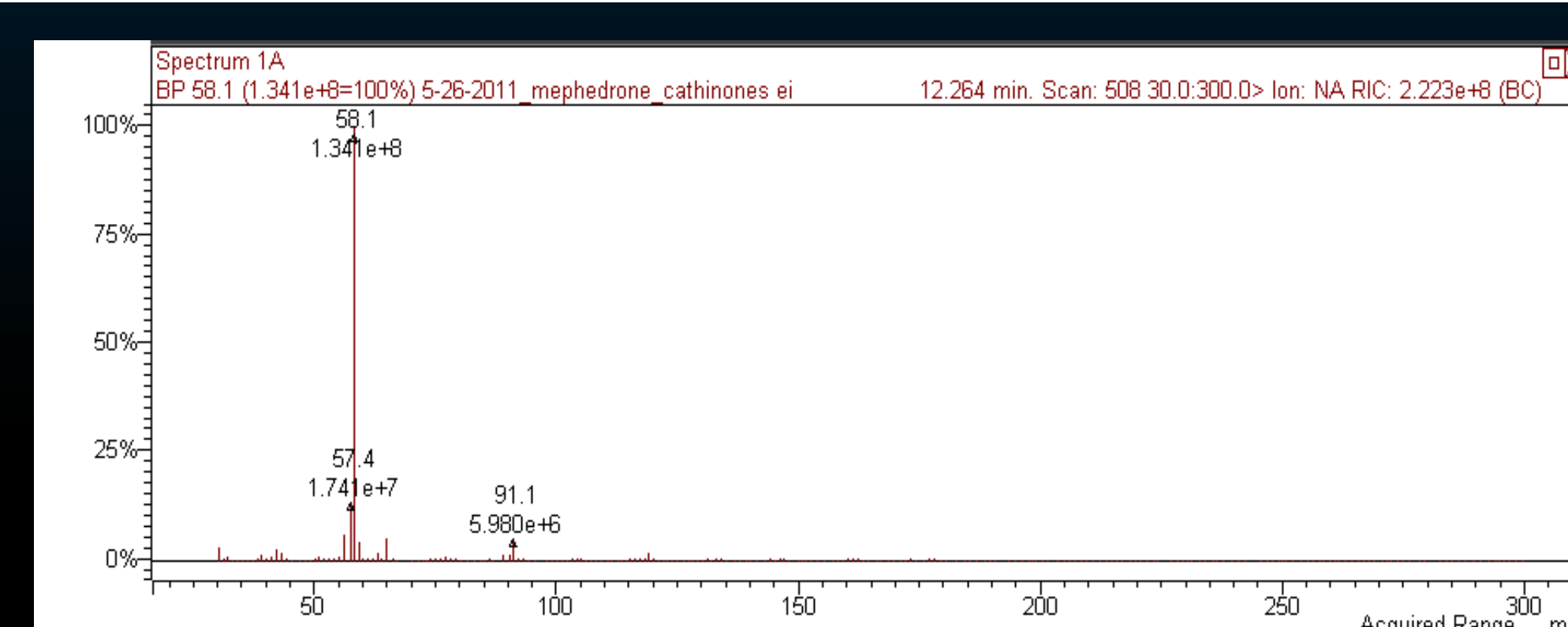
Synthetic cathinones have been sold as “bath salts” or “plant food.” Product names include Ivory Wave, Vanilla Sky, Energy 1, White Lightning, and Hurricane Charlie. Mephedrone, methedrone, and MDPV are some of the most common compounds seen in “bath salts.” They are structurally similar to the stimulants cathinone and methcathinone. Many other synthetic cathinones are also structurally similar to each other. As a result, they have similar fragmentation patterns when characterized by traditional GC-EIMS methods; therefore, the EI mass spectra are not particularly useful for identification.

In this study, EI and CI, and single and triple quadrupole (QqQ) mass spectrometry were evaluated in order to determine the most definitive method for identification of synthetic cathinones.

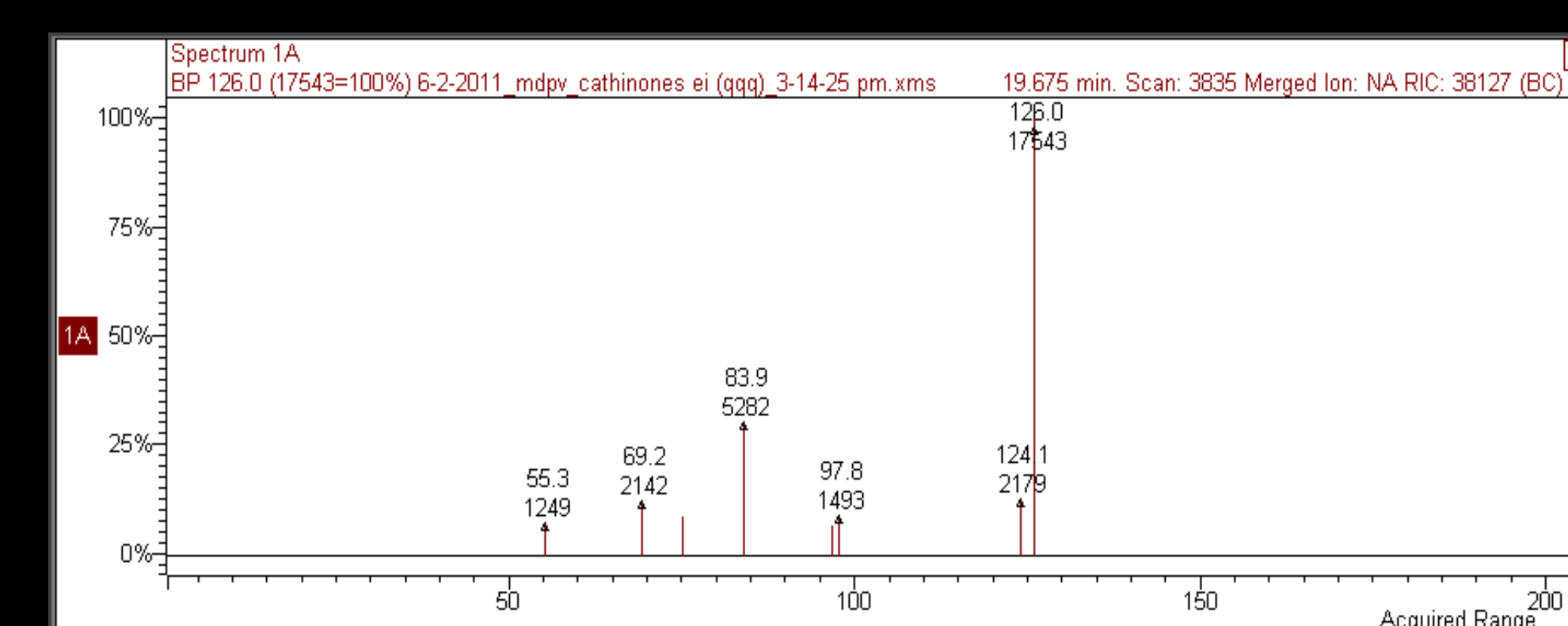
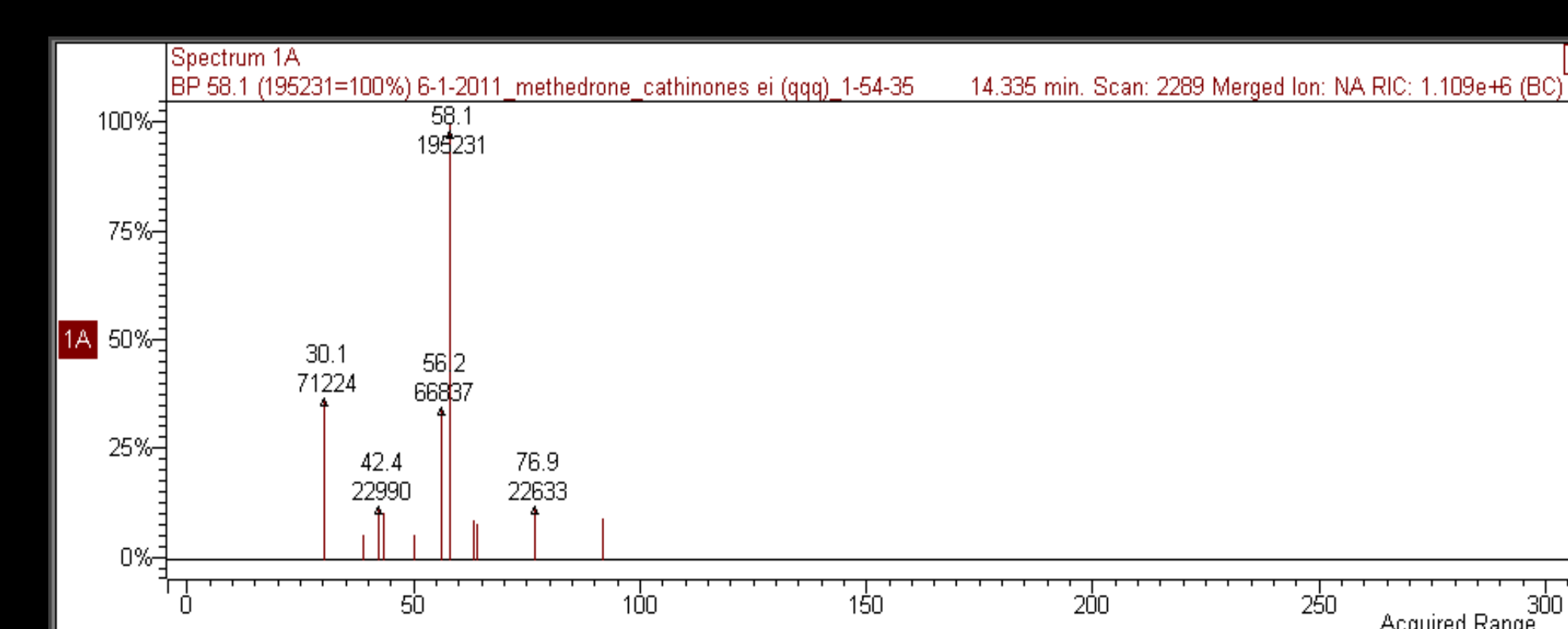
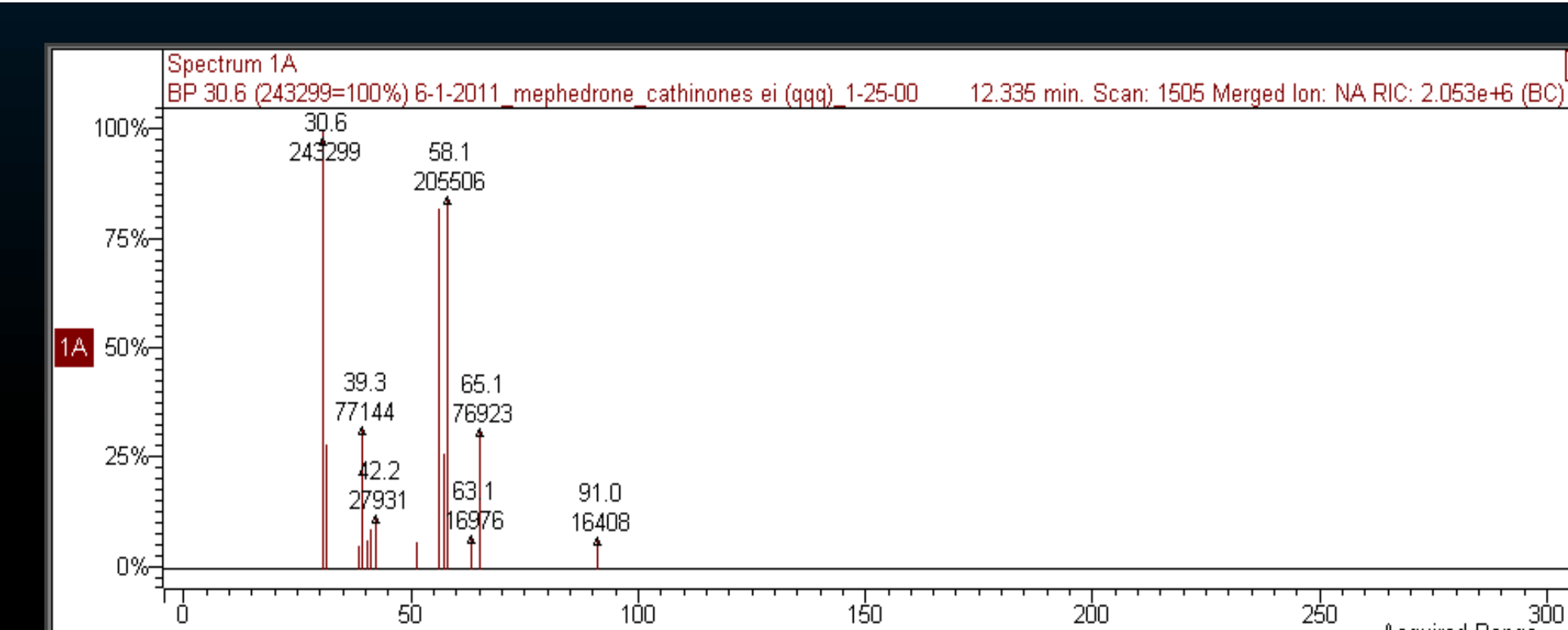
MATERIALS AND METHODS

- Mephedrone (Cerilliant) [100 ng/μL]
- Methedrone (Cerilliant) [100 ng/μL]
- MDPV (Cayman Chemical) [5 ng/μL]
- Varian CP-3800 GC/1200 MS
 - Column: VF-5ms FactorFour (30m x 0.25mm x 0.25μm)
 - Injection volume: 1μL
 - Reagent gas (CI): methane
 - Source pressure (CI): 3.5 Torr
 - Filament current: 50μA (EI), 250μA (CI)
 - CID gas: argon
 - CID pressure: 1.5 mTorr
- Research Temperature Program
 - Initial: 80°C (3 min)
 - Ramp: 10°C/min
 - Final: 280°C (3 min)
 - Total run time: 26 min
- Final Temperature Program
 - Initial: 100°C (1 min)
 - Ramp: 200°C, 20°C/min
 - Final: 290°C, 30°C/min (1 min)
 - Total run time: 10 min

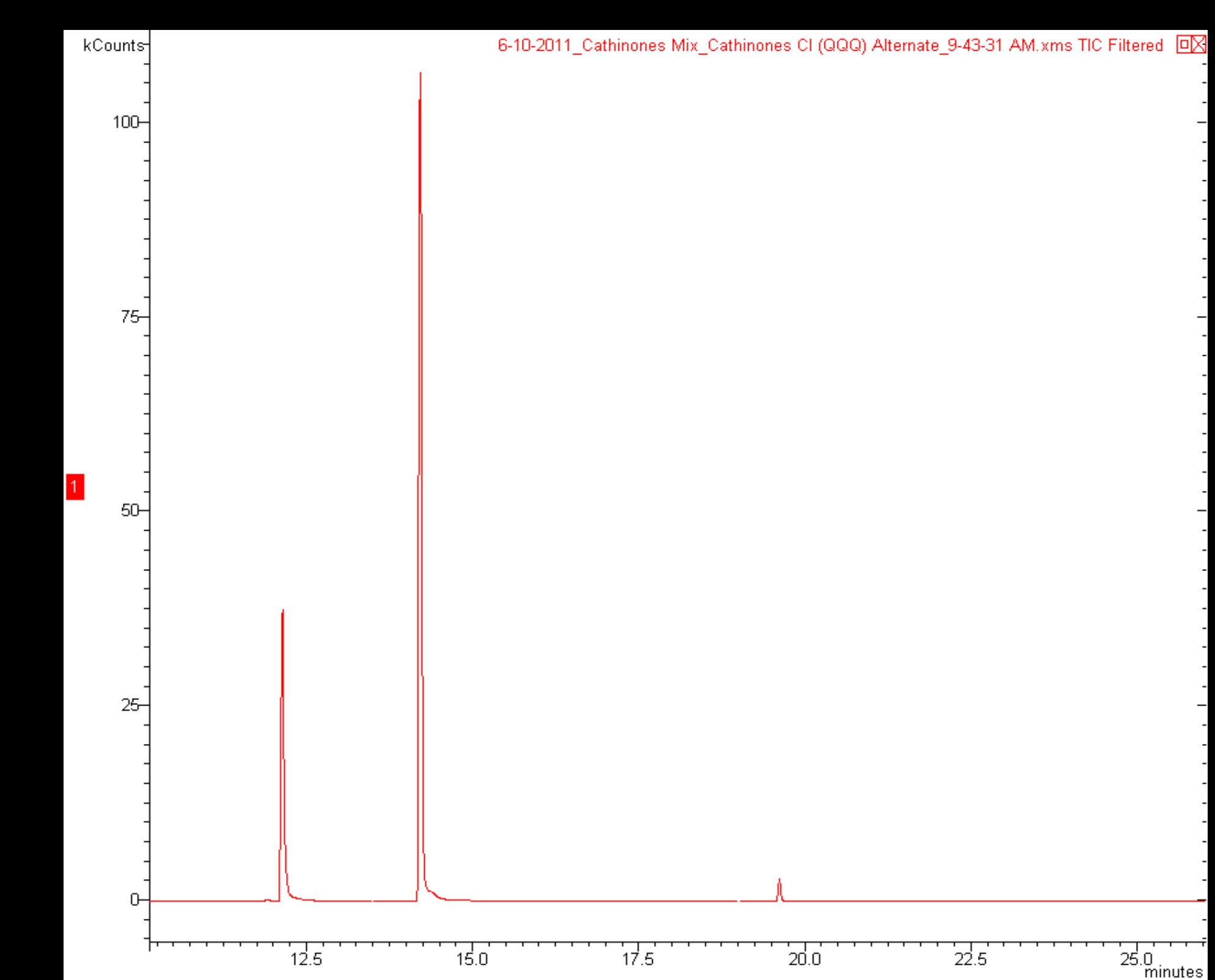
RESULTS



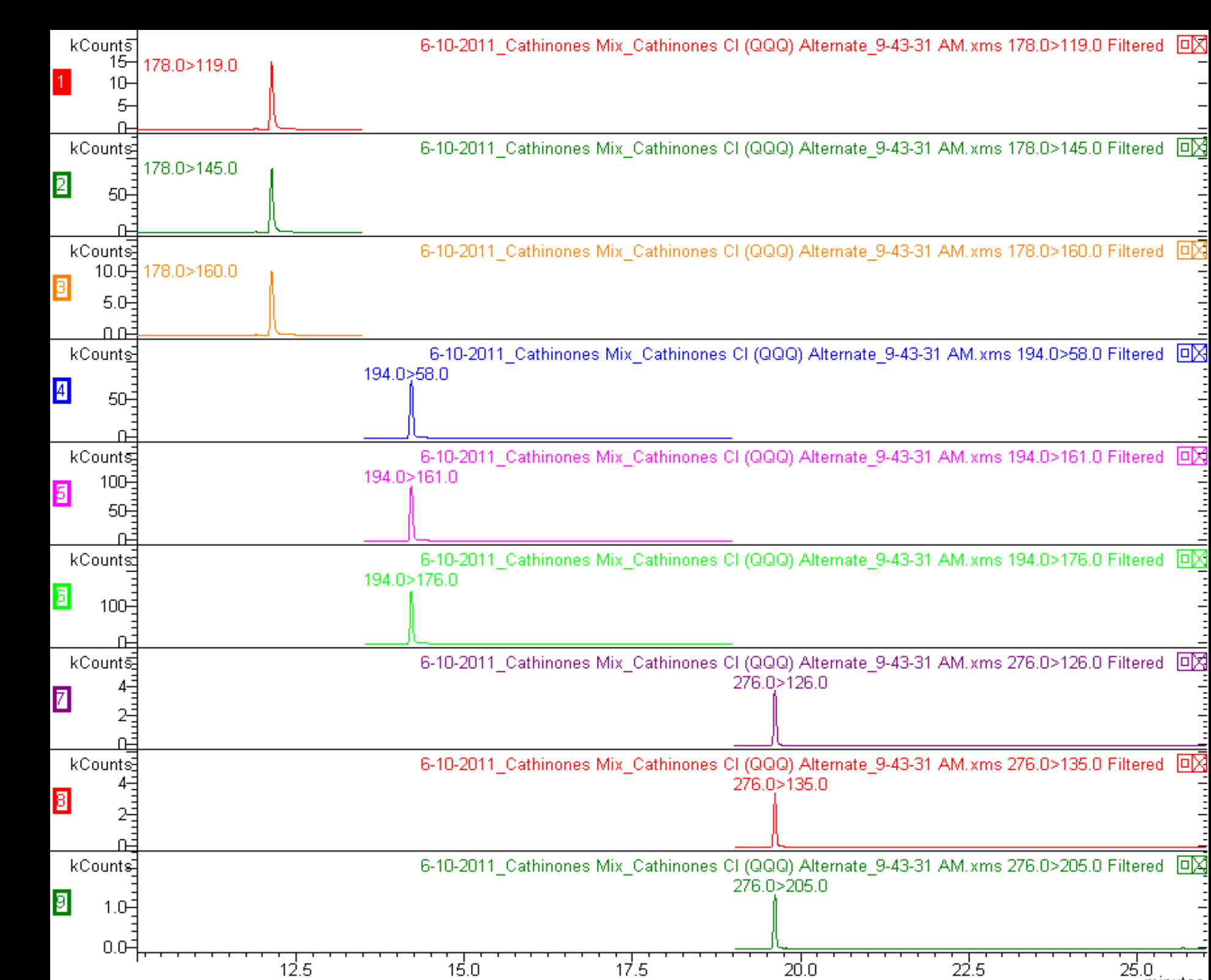
EI single quadrupole mass spectra for mephedrone (1), methedrone (2), and MDPV (3)



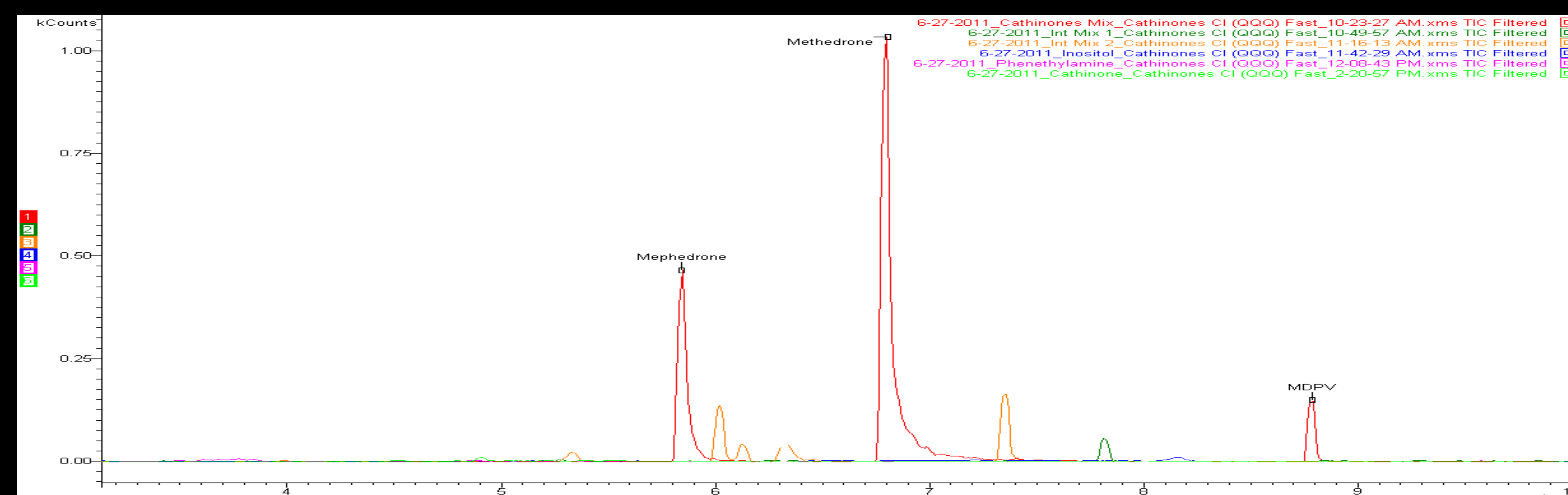
EI triple quadrupole full scan mass spectra for mephedrone (1), methedrone (2), and MDPV (3)



CI triple quadrupole MRM total ion chromatogram for the Synthetic Cathinones Mix, containing mephedrone (1), methedrone (2), and MDPV (3).



CI triple quadrupole MRM product ion chromatograms for the Synthetic Cathinones Mix, containing mephedrone (1), methedrone (2), and MDPV (3).



Overlaid chromatograms of the Synthetic Cathinones Mix (mephedrone, methedrone, MDPV), Interference Mix 1 (amphetamine, phentermine, cathine, ephedrine, caffeine, ketamine), Interference Mix 2 (methamphetamine, pseudoephedrine, MDA, BZP, TFMP, MDMA, cocaine, codeine, diazepam, hydrocodone, oxycodone, alprazolam, clonazepam, heroin), inositol, phenethylamine, and cathinone.

DISCUSSION

- *EI Q*: MDPV is distinguishable from the other two compounds, but cannot be definitively identified. Mephedrone and methedrone spectra were very similar, with strong *m/z* 58 ions and little else.
- *EI QqQ*: MDPV exhibited a more characteristic spectrum. The other two remained indistinguishable from one another due to low-detail fragmentation, but the abundance of the ions was increased.
- *CI Q*: Soft ionization produced low-detail fragmentation in all spectra. Each spectrum included a protonated molecular ion.
- *CI QqQ*: Selecting the $[M+H]^+$ for each compound produced spectra that allowed for differentiation and identification. Unique fragments were detected due to the soft ionization and sensitivity from QqQ analysis. Fragments were then chosen from each full scan to create a more sensitive and selective MRM method, where each compound produced a clean peak and unique spectrum.
- No interference occurred during the CI QqQ MRM analysis of 23 compounds with similarities in physical appearance or structure.

CONCLUSION

While some useful data can be obtained for mephedrone, methedrone, and MDPV using EI and CI in single and triple quadrupole analyses, the developed method utilizing CI QqQ provides the most definitive results for the identification of the studied compounds. It, too, is most likely to provide such conclusive data for other synthetic cathinones encountered in the future. CI produces protonated molecular ions of high enough intensity to be suitable precursor ions. Triple quadrupole analysis allows for the creation and detection of ions unique to a given compound, regardless of similar structures or chromatographic retention times.

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