

K39 Evaluation of the Components Within Electronic Cigarette Liquids and Drugs of Abuse Using Gas Chromatography/Mass Spectrometry (GC/MS) and Ultra-Fast Liquid Chromatography Tandem Mass Spectrometry (LC/MS/MS)

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After attending this presentation, attendees will have a better understanding of electronic cigarettes, electronic cigarette liquids, the growing trend of using these products to abuse drugs, and how to analyze electronic cigarette liquids suspected of containing drugs of abuse.

This presentation will impact the forensic science community by demonstrating that detection and quantification of drugs of abuse added to electronic cigarette liquids is possible and by describing the effect that the electronic cigarette liquid matrix has on these results.

As electronic cigarettes become more prevalent in society, their use as a delivery mechanism for drugs of abuse has increased. Electronic cigarette liquids present a complex matrix due to the lack of regulation, and therefore standardization, in their manufacturing. A growing trend on internet drug forums involves how to best add drugs of abuse to electronic cigarette liquids for abuse via an electronic cigarette. Due to the lack of published data, development of new analytical methods to accommodate this growing trend was deemed necessary.

GC/MS and LC/MS/MS methods were developed to identify the flavorants of the electronic cigarette liquids as well as identify and quantify nicotine and common drugs of abuse used with these devices.

Seven drugs of abuse were investigated: methamphetamine, heroin, cocaine, fentanyl, and the synthetic cannabinoids JWH-081, JWH-018, and AM-2201. Electronic cigarette liquids from five manufacturers were sampled. From each manufacturer five “flavors” of liquids were chosen. Each liquid “flavor” was tested at the manufacture’s reported nicotine concentrations of 0mg/mL, 12mg/mL, and 24mg/mL for a total of 75 electronic cigarette liquid samples.

Liquid-liquid extraction was performed on all samples prior to analysis by GC/MS and LC/MS/MS. Analysis was performed in replicates of five to identify the electronic cigarette liquid components as well as to quantify nicotine and the seven analytes of interest. For any electronic cigarette liquid labeled as containing 0mg/mL of nicotine in which nicotine was identified, the sample was analyzed by GC/MS to quantify the nicotine level. Due to the fact that e-liquids are not regulated, and there is no acceptable concentration of nicotine allowed in a product labeled as containing no nicotine, these concentrations were compared to the naturally occurring levels of nicotine found in certain food products to determine statistical significance.

Identification of the flavorants of the electronic cigarette liquids as well as the quantitation of nicotine and the four commonly abused drugs was accomplished using GC/MS and LC/MS/MS. Nearly all of the flavorants detected have been approved by the Food and Drug Administration for use in food products, but the effects these flavorants have when used via inhalation has not been studied in detail; however, one compound, glutethimide, has not been approved for use in food products and is listed on the Title 21 United States Code Controlled Substance Act as a Schedule II compound.

Samples of e-liquids labeled by the manufacturer as containing 0mg/mL of nicotine may contain detectable and quantifiable levels of nicotine, with concentrations ranging from 31µg/mL to 415µg/mL. Quantitation of drugs of abuse may be affected by matrix components and was found to be dependent on both the specific e-liquid being used with the electronic cigarette as well as the analyte being investigated. For analysis by GC/MS, the e-liquid samples were spiked at a concentration of 150µg/mL with methamphetamine, cocaine, heroin, and fentanyl. Methamphetamine was unable to be quantitated, the calculated concentrations of cocaine ranged from 68.53µg/mL to 177.8µg/mL, the calculated concentrations of heroin ranged from 71.51µg/mL to 197.9µg/mL, and the calculated concentrations of fentanyl ranged from 63.31µg/mL to 211.8µg/mL.



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For analysis by LC/MS/MS, the e-liquid samples were spiked at three different concentrations: 40ng/mL, 400ng/mL, and 1,500ng/mL. JWH-081, JWH-018, AM-2201, and heroin were determined to be either inaccurate or imprecise across all three spiked concentrations. Methamphetamine, cocaine, and fentanyl were determined to be the most accurate and precise across all three spiked concentrations, in all e-liquid matrices analyzed by LC/MS/MS.

E-Liquids, GC/MS, LC/MS/MS