K9 The Determination of the Organic Components of Newer Generation E-Cigarette Liquids

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Learning Overview: After attending this presentation, attendees will learn how Gas Chromatography coupled to Mass Spectrometry (GC/MS) can be utilized to identify and quantify targeted chemical components in newer generation e-cigarette products. This will include products that contain cannabinoid compounds, such as Cannabidiol (CBD), in addition to nicotine and other materials.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing analysts with a relatively simple method to analyze e-cigarette products and informing them about the potential harms the constituents of e-cigarette liquids may pose to the public without proper product regulation and quality control measures.

In 2003, the electronic cigarette (also known as an e-cigarette, electronic nicotine delivery system or ENDS, vaporizer device, vape pen, etc.) was introduced to the global market, reaching the United States in 2007, and quickly growing into an extremely lucrative enterprise.[1,2] E-cigarettes differ from traditional cigarettes through the use of a heating element/atomizer to heat a cartridge composed of purified and processed nicotine, propylene glycol, vegetable glycerin, additives, and flavorings to the point of vaporization.[2-7] This vapor is then inhaled by the user. It is hypothesized that e-cigarettes have become such a successful product due to being heavily marketed as a smoking cessation aid and as a "healthy" alternative to traditional cigarettes.[2,5,6,8,9] Additionally, companies are using more modern market avenues to advertise and sell their products and are offering an extremely wide variety of nicotine concentrations and flavors that are not available for cigarettes and other nicotine alternatives.[2,5,6,8,9] E-cigarette vaporizers range from the first generation "cig-alike" devices to highly customizable third generation "mods" to the more recent and well known JUUL™.[5]

Recently, e-cigarettes have been focused on by the media with claims of lack of regulation by the Food and Drug Administration (FDA) and poor quality control.[3,8-10] The absence of these measures has resulted in inconsistent policies at the local, state, and federal levels and a lack of knowledge about the substances present in e-liquid and the subsequent produced vapor.[6] However, the largest issue addressed includes accusations that the introduction of e-cigarettes has sparked an epidemic of nicotine addiction among American youth that may act as a gateway for non-smokers to transition to traditional smoking or more illicit drug use.[1,2,5,6,9,11-13] The goal of this project is to further investigate and possibly identify the potentially harmful chemical components either present, or created through the use of, newer e-cigarette products common among young people in the United States.

Different types of e-cigarette liquid and devices were investigated in this project, including bulk e-liquids with a SMOK® MAG Kit third-generation device or "mod", JUUL™ and JUUL™-compatible cartridges (this includes JUUL™, SEA100™, and Hempzilla™ pods) with a JUUL™ e-cigarette device, and thicker CBD oils and/or cannabis e-liquid cartridges with a Yocan® Evolve 2.0 Vape Pen. Samples were prepared by attaching the vaporizer devices to a smoking pump to produce vapor for each e-liquid. This vapor was pulled through a water trap in a glass impinger in order for its components to be trapped in the water and separated from the viscous propylene glycol and vegetable glycerin found in e-liquids, which are not very compatible with GC/MS systems. A liquid-liquid extraction was then performed with dichloromethane, and the samples were analyzed with an Agilent® 7890A GC and a 5975C inert MSD with Triple Axis Detector. The column utilized for separation was an Rtx-5 column (Restek®; 30m, 0.25mm ID, 0.25um film thickness). Targeted sample components were identified using the National Institute of Standards and Technology (NIST) 2014 database and comparison to certified reference materials. Identified components were quantified via calibration standards for each target. Substances of interest included nicotine, formaldehyde, acetaldehyde, diacetyl, acetyl propionyl, CBD, THC, and others. This selection was based on previous research regarding the harmful components found in traditional cigarettes and potentially in e-cigarette products.

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E-Cigarette, Gas Chromatography, Drug Chemistry