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Determination of Nicotine and Its Metabolites in Hair of Vapers and Non-Vapers Using GC-MS

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Structured Abstract

Background: The increasing use of e-cigarettes has caused worries about long-term nicotine exposure. Unlike regular cigarettes, e-cigarettes often have various types, and free-base nicotine might change how it is absorbed into the body. Hair analysis offers a non-invasive and retrospective approach for assessing chronic nicotine exposure. However, limited studies have addressed the determination of nicotine and its metabolites in the hair of vape users. This study aimed to determine and compare nicotine levels in hair samples from vapers and non-vapers using gas chromatography–mass spectrometry (GC-MS).

Methods: Hair samples were collected from selected vapers and non-vapers and subjected to a standardized decontamination procedure using dichloromethane to remove external contaminants, followed by drying in an incubator at 30 °C. Dried hair strands were cut and minced approximately 1 mm segments, 10 mg of each sample was then weighed for analysis. Alkaline digestion was employed using 1M sodium hydroxide to release nicotine from the hair's keratin matrix. The digested samples were then centrifuged at 2500 rpm for 5 minutes. Nicotine and cotinine were extracted using solvent extraction with a methanol–chloroform solvent mixture (1:3, v/v) followed by analysis using GC-MS under full scan mode.

Results: This study shows no detectable nicotine or cotinine in any of the analysed hair samples from vapers or non-vapers. All samples tested negative for both substances, indicating that their concentrations, if present, were below the detection limit of the GC–MS method operated in full-scan mode. The consistent non-detection across all samples supports the reliability of the analytical procedure and suggests that the absence of detectable nicotine and cotinine reflects limited analytical sensitivity rather than procedural error or contamination. These findings highlight the challenges of detecting trace-level nicotine incorporation in hair using full-scan GC–MS.

Conclusion: In conclusion, the findings of this study indicated that the consistent non-detection across all samples indicates that analyte concentrations were below the method's detection capability. To reliably find these trace amounts in hair samples for forensic analysis, the use of more sensitive techniques like selected ion monitoring is recommended to improve the current method.

Keywords: Nicotine, vapers, non-vapers, hair analysis, e-cigarettes

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