H92 An Investigation of Volatile Profiles of Specific Human Organs During Decomposition

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Learning Overview: After attending this presentation, attendees will understand which Volatile Organic Compounds (VOCs) are released from specific human organs, as well as their trends over time as organs decompose.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by demonstrating the potential of decomposition VOC profiling for postmortem examinations and its value as a tool to improve postmortem interval estimation and/or the determination of antemortem conditions.

The human body is made up of multiple complex biological systems. Despite great advances in science and technology, understanding how these systems are linked together and their influence on each other remains a complex task. Death involves the shutdown of these systems, initiating a sequence of events that breaks the body down into its smallest components; these processes are influenced by intrinsic factors such as diet, age, or gender and extrinsic factors such as temperature or humidity. Comprehensive knowledge of human decomposition processes would allow advancements to be made in many crucial forensic applications, including the determination of the postmortem interval or the examination of physical conditions prior to death, which can help to reconstruct antemortem events.

Comprehensive Gas Chromatography coupled to Time-Of-Flight/Mass Spectrometry (GCxGC-TOF/MS) is commonly used to study complex mixtures of VOCs from biological specimens. The objective of this research was to determine the VOCs present during the decomposition of human tissues, along with their respective postmortem trends over time using GCxGC-TOF/MS. Previous research has been largely focused on the analysis of VOCs produced by whole animal or human cadavers. However, this study aimed to identify whether the VOCs produced as a result of decomposition differ between specific organs within a body and, further, to determine the extent of variation between organs in different individuals. The study design allowed for intra- and inter-cadaver comparison for each organ sampled. Heart, lung, liver, kidney, and blood were collected from five bodies. The headspace was monitored during the decomposition process. Tissues were split into replicate glass jars and the headspace was sampled by dynamic pumping onto sorbent tubes that were further thermally desorbed onto a GCxGC-TOF/MS system. Due to the number of cadavers, organs, replicates, and time points analyzed, a large amount of data was obtained, leading to challenges in the integration, interpretation, and representation of the results. To monitor the temporal changes in VOC profiles, multivariate statistical methods, such as Principal Components Analysis (PCA) and Hierarchical Cluster Analysis (HCA) were applied to the dataset to evaluate trends and differences in subgroups.

The first approach was an intra-cadaver approach, where the profile from each organ was compared within a single body for all measured time points. The second approach consisted of an inter-cadaver comparison, where the VOC profiles for a single organ were compared between different bodies at each time point. The intra-cadaver analyses demonstrated that all organs from one body followed a similar trend, despite distinct differences at each time point. Examining the temporal trends, some cadavers exhibited similar trends; however, it was challenging to determine global trends across samples from all bodies. The inter-cadaver analysis focused on the comparison of the different tissues types from the five bodies at selected time points. Distinctive VOCs for each tissue for each time point could be determined. Furthermore, differences were demonstrated for the compounds produced from each organ, which is likely related to their composition based on the different functions they perform within the body. Differences observed in the VOC profiles between the analyzed bodies could range from the individual diet and lifestyle to the cause of death, as all these aspects have an impact on taphonomic processes.

This research is significant because it is the first study monitoring a high number of human tissues during decomposition. The increased number of samples and the use of technical replicates allowed a high quality of analytical data and an assessment of variance for inter- and intra-cadaveric samples. This will provide a foundational basis for the future implementation of VOC profiling from cadavers in forensic casework.

Decomposition, Volatile Organic Compounds (VOCs), Human Organs