B58 Blood Decomposition Odor Profiling: An Instrumental and Field Application Tool in Forensic Detection

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Learning Overview: The goal of this presentation is to provide better understanding of the specific Volatile Organic Compounds (VOCs) emitted from decomposing blood evaluated over specific time intervals and how the detected blood odor profile can be utilized as a marker of chemical detection effectiveness during field work applications.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by its novelty of being one of the first studies to evaluate and created a blood decomposition profile and one of the first to evaluate commonly used presumptive reagents like Bluestar® and Luminol to correlate the field response with the specific odor signature for a blood decomposition time frame.

This presentation will deliver strong scientific perspectives, implementing both chemical laboratory and field findings, regarding the characterization of blood odor volatiles as a function of decomposition time. Blood is a vital biological body fluid found in most living organisms. Blood is an important serological medium which can be tested to detect diseases, inflammation, pregnancy, infections, anemia, and other conditions like cancers or bleeding disorders. DNA and blood pattern analysis in criminal investigations is crucial in determining the victim(s) or suspect(s), the velocity, distance, weapon, and impact utilized during a crime. However, there is limited literature on the correlation between blood analysis and the victim's time of death. Therefore, this study sheds light on the odor volatile composition of a decomposing blood sample matrix as a function of time. This research further enhances optimum serological (blood) evidence decomposition detection procedures for purposes of estimating time of death based on the emitted VOCs. A novel approach to this study is that it also integrates the detection effects of presumptive reagents in response to the blood decomposition time frame. The optimal implementation of blood decomposition odor profiling and the ability of presumptive reagents to detect levels of decomposed blood impacts the forensic field by providing a valuable, highly deployable lab, and field tool for the biological detection of evidence.

There is a research gap in the evaluation of blood decomposition processes and the use of potential blood decomposition odor markers in establishing time of death ranges. Onset of coagulation in terms of blood decomposition can potentially display vital signs in determining how long the blood has been drying. Research exploiting the use of canines for cadaver detection has associated challenges regarding the age of the blood used as a training aid, and ultimately a lack of scientific foundation as to the odor signatures with respect to decomposition time. This novel research is an evaluation of how many volatile organic compounds (VOCs) are present during various stages of decomposition. This study will be the first to conduct blood decomposition odor profiles for the presence of VOCs using a GC/MS (gas chromatograph/mass spectrometer) targeting specific time windows as a function of volatile odor patterns. The purpose of this research further intends to increase the knowledge of detection windows of presumptive reagents, Bluestar and Luminol, by introducing a parallel understanding of distinctive volatile odor profiles in relation to the number of resulting false positives and the observable intensity based on apparent fluorescence. This study analyzed blood at three distinctive time frames of decomposition: fresh (0-48 hours), intermediate (49-96 hours), and late (97-168 hours) potentially revealing different VOCs specific to each phase. Instrumental evaluation utilized Divnylbenzene/Carboxen/Polydimethylsiloxane (DVB/CAR/ PDMS) coated Solid Phase Microextraction (SPME) fibers that were injected into a GC/MS system for the identification of extracted blood decomposition odor profiles at each of the three decomposition time frames. Within the three-phase, two substrates were analyzed: cotton gauze pads and metal nails (zinc/iron and copper), to determine if the amount of detected VOCs present in natural blood decomposition is affected by the substrate's composition.

The significance of this work was to show that the odor profile resulted in several volatile organic compounds of varying functional groups which could potentially suggest and support how long the victim has been dead (postmortem interval (PMI)) regarding the deposition of blood at a crime scene. It is also one of the first studies to evaluate commonly used chemical reagents such as Bluestar and Luminol and correlate the field response with the specific odor signature for that blood sample time frame. This research presents a bridge to the knowledge gap of blood odor profile composition and presumptive reagents.

Blood Decomposition VOCs, Solid-Phase Microextraction, GC/MS