K22 Analysis of Volatile Organic Compounds Emitted During Aerobic Decomposition of Various Swine Tissues

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After attending this presentation, attendees will learn about the analytical methods for the analysis of analytes released from decomposing animal tissues and organs. Cryogenic and sorbent preconcentration of ultratrace analytes are used in conjunction with gas chromatography-mass spectrometry (GC/MS) and pre-evacuated bottle or canisters for sample collection. The identity of the volatile organic compounds (VOCs) discovered and their relationship to the decomposition process will be discussed. The findings and methodologies will have important implications in understanding the chemistry of decomposition and the postmortem interval (PMI) in addition to improving the efficiency in search and recovery of dead human or animal remains.

This presentation will impact the forensic science community by providing important information on the profile of chemical compounds emitted from various tissues of animal carcasses, correlating the specific parts of the carcass with unique identities of compounds released, and their relationship to the different stages of the decomposition process. Knowledge related to the decomposition process could also improve the search and recovery of victims as well as provide crucial evidence for convicting or acquitting suspects in murder trials.

In a recent trial case, emitted volatile organic compounds (VOCs) found in the trunk of the car used by the accused for transporting human remains was introduced as evidence for the first time. However, just like with any new evidence, lawyers were able to discredit this evidence due to lack of knowledge and the need for further research. The goal of this research is to elucidate the decomposition mechanisms of animal carcasses that might yield forensic clues in the investigation of human remains.

Variable environmental conditions, the presence of microorganisms and the disposal mode of the animal or human remains, as well as the amount of time elapsed once the decomposition process has taken place greatly influence the emission profile of the VOCs. Statheroproulos et al.[1] and Vass et al.[2] independently measured more than 100 VOCs that were released during the decomposition of human remains. However, these studies involve the presence of body bags or other burial conditions including the soil matrix, insects, and microorganisms that are typically associated with decomposition. In this study, the influence of environmental media (e.g., soil, sand, water) in the decomposition process was minimized by conducting the study of decomposing tissues in glass vessels that are configured with a leak-proof design for efficient collection of compounds emitted from the degradation of tissues. Samples were collected approximately three times a week over a period of ten weeks using pre-evacuated bottles or canister that were analyzed by gas chromatography-mass spectrometry (GC/MS) with analyte enrichment on a 3-trap preconcentrator.

The predominant classes of compounds found in decomposing tissues include sulfur-containing compounds, esters, and aldehydes. The data shows that aldehydes are formed more readily in organs and in general, aldehydes with five or six carbons, i.e., petanal, hexanal, and 3-methyl butanal were found at the highest concentrations. Several ketones and esters were found in the muscle and skin samples whereas 1,1-difluoroethane was found to be characteristic in bone decomposition. The presence of sulfur-containing compounds such as carbon disulfide, methanethiol, dimethylsulfide, dimethyldisulfide, and dimethyltrisulfide could be linked to the biochemical degradation of sulfur-containing amino acids like methionine, cystine, and cysteine that constitute the swine tissues or organs. The presence of dimethyldisulfide and dimethyltrisulfide may be linked to cystine, which is due to the dimerization of two cysteine units and is commonly found in collagen (e.g., connective tissue) and keratin (hooves and hair).

The cryofocusing GC/MS technique based on a 60-meter column with dimethylsiloxane stationary phase was able to detect alkanes with carbon numbers ranging from 3 to 14 as well as aliphatic alcohols with 2-8 carbons. The detection limits of the compounds released from the decomposition of porcine tissues are generally in the 0.1 to 20 parts per billion levels. With the current study of tissue-specific or organ-specific decomposition studies, valuable information will be gleaned for strengthening the credibility of evidence involving odor analysis pertaining to human decomposition in court.

References:

[1] Stratheropoulos, M.; Spiliopoulou, C.; Agapiou, A. Environmental aspects of VOCs evolved in the early stages of human decomposition. Science of the Total Environment. 2007, 385, 221- 27

[2] Vass, AA.; Smith, RR.; Thompson, CV.; Burnett, MN.; Wolf, DA.; Synstelien, JA. Decompositional odor analysis data base. J. Forensic Sci. 2004, 49, 1-10.

VOC Analysis, Decomposition Chemistry, Animal Carcass

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