GC×GC-HRTOFMS for Cadaveric Odor Analysis: A Forensic Case Study

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Objectives: Odor analysis is still highly controversial in the legal system regardless of its foundation in well-established gas chromatography – mass spectrometry (GC-MS) techniques. Despite extensive research characterizing decomposition odor, it has been disputed in a recent court case as being too untested (1). The literature depicts a different story whereby GC-MS analysis of decomposition odor is rapidly becoming outdated and replaced by comprehensive two-dimensional gas chromatography – mass spectrometry (GC×GC-MS). It has been demonstrated that GC×GC coupled with high-resolution time-of-flight mass spectrometry (HRTOFMS) is a valuable tool for the analysis of volatile organic compounds (VOCs) from decomposing cadavers (2). In this study, soil and adipocere samples from a forensic case were recovered at a site were a decomposing body was found. The goals were to accurately profile decomposition odor from case samples using GC×GC, establish the start of a long-term case study, and understand future challenges in real case scenarios.

Method: The headspace of soil and adipocere were sampled in triplicates for 15 min at 40 °C using solid-phase microextraction. Samples were analyzed using GC×GC-HRTOFMS. An Agilent gas chromatograph and a Pegasus HRT time-of-flight mass spectrometer (LECO® Corporation, St. Joseph, MI, USA) were used. The first dimension (1D) column was a 30 m × 0.25 mm × 1.40 µm Rxi-624Sil MS (Restek® Corporation) and the second dimension (2D) column was a 2 m × 0.25mm × 0.50 µm Stabilwax (Restek® Corporation). The modulation period (P_M) was 4 s with a 0.60 s hot pulse time. Data were acquired at 200 spectra/s (29–450 *m/z*).

Results: Adipocere and soil samples from the cadaver decomposition island were collected at the discovery site to reflect the heterogeneity of the decomposition environment. VOCs identified in the soil samples reflected previous studies, while the profile of adipocere was demonstrated for the first time by GC×GC-MS and was dominated by volatile acids and esters. Difficulties were identified with interpreting complex decomposition VOC mixtures due the low specificity of VOCs; therefore, VOC quantification and ratios were recognized as being important for future advancement. The power of GC×GC images in court testimony was considered to be of high potential.

Conclusions: This study represents the first application of GC×GC in a realistic case scenario, which demonstrates the progression of this technique in the field in past years.

References:

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