A92 The Detection and Characterization of Human Decomposition Products by Infrared Spectroscopy

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Learning Overview: After attending this presentation, attendees will understand: (1) how human decomposition products in soil can be detected in the lab with Mid-Infrared (MIR) spectroscopy and in the field with Near-Infrared (NIR) spectroscopy; and (2) how the stage of decomposition, indicative of the Postmortem Interval (PMI), can be estimated from the spectra.

Impact on the Forensic Science Community: This presentation will impact the forensic science community by providing homicide investigators with a method of detection and characterization of human remains located either on the soil surface or within clandestine burials.

After death, the neutral fats of adipose tissue decompose to fatty acids, both saturated and unsaturated. Over time, the unsaturated fatty acids are converted first to saturated fatty acids and eventually to insoluble salts that are relatively immobile and long lasting. These fatty acids and their salts contain long carbon chains consisting primarily of methylene groups (-CH_2-) that have characteristic features in the infrared spectrum, both in the MIR and NIR regions. Buried human remains decompose under largely anaerobic conditions, where the decomposition process is relatively slow. Human remains on the ground surface are in aerobic conditions, and therefore decomposition of cadavers on the surface proceeds more quickly.

This study acquired spectra of several different types of soil samples in order to determine how MIR and NIR spectra can be used to detect these fatty acids in the soil: (1) soil with added saturated and unsaturated fatty acids of known concentrations, (2) soil from a mock crime scene using a pig as a proxy for a human cadaver in Ohio, and (3) soil taken from the vicinity of four decomposing human cadavers, on the surface and in burials, at the Facility for Outdoor Research and Training (FORT) in the Institute of Forensic Anthropology and Applied Sciences at University of South Florida. The presence of human remains was successfully detected in the soil samples in both spectral regions, MIR and NIR. In addition, it was demonstrated that fatty acid concentrations varied depending upon the region of the cadaver (e.g., head, pelvis, torso, feet) and the depth and distance from a cadaver that a sample was taken. In the MIR, the spectroscopic signatures of saturated and unsaturated fatty acids are distinguishable, yielding information about the extent of the decomposition and hence about the PMI. Measurements on background soil samples indicate a very small fatty acid background (~3%), not attributable to the presence of a cadaver. This background signal has a characteristic spectral signature that can be distinguished from the burial remains. The characteristic fatty acid peaks in the NIR represent the overtones of the absorptions of the fundamental vibrations in the MIR, and thus are very much less intense. Nonetheless, these weaker NIR peaks have been observed for each cadaver for which MIR peaks were observed. The advantage of the NIR measurement is the possibility of *in situ* measurements in the field. Such field measurements employ a spectroscopic probe that is pushed into the soil and connected to spectrometers on the surface by fiber optics.[1] Thus, these spectroscopic methods can be used in the field for the detection and characterization of clandestine human burials.

Reference(s):

1. Matney T., Barrett L., Dawadi M.B., Maki D., Maxton C., Perry D.S., Roper D.C., Somers L., Whitman L.G. *In situ* shallow subsurface reflectance spectroscopy of archaeological soils and features: A case-study of two Native American settlement sites in Kansas, *J. Archaeol. Sci*. 2014; 43:315-324.

Human Decomposition Product, Infrared Spectroscopy, Clandestine Burial

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